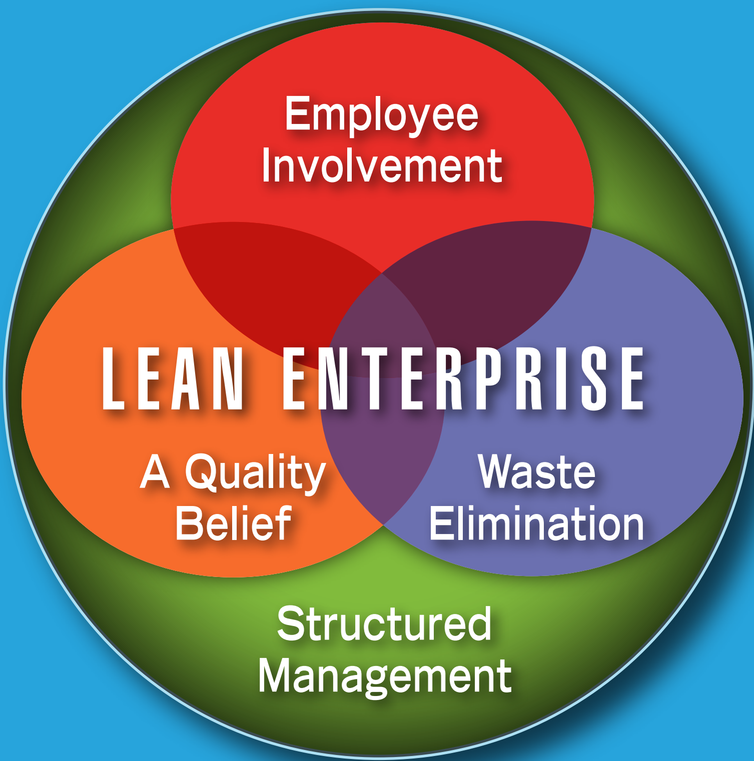
The LEAN MANAGEMENT SYSTEMS HANDBOOK



Rich Charron • H. James Harrington • Frank Voehl • Hal Wiggin

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Management Handbooks for Results

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This book is dedicated to the two most influential women in my lifetime: my late mom, Helen M. (Sharkey) Charron, and my daughter, Hali Charron.

To my mom, who selflessly did for me the thousands of things that make moms … moms. She gave me enough freedom for skinned knees and hockey game hospital trips, but knew exactly when to step in and provide course correction before real trouble could become real trouble. I love you and miss you, mom.

To my precious daughter, Hali, who as a child opened my eyes to life lessons that irreversibly changed my understanding of what is important and what is not. As a young woman, she continues to both amaze me and make me proud on a daily basis. Love you, Hali.

—Richard Charron

This handbook is dedicated to our friends and mentors: Armand "Val" Fiegenbaum, one of the "Four Horsemen" of the Lean Quality Movement, who never met a problem he could not solve; and to Marshall MacDonald, FPL Chairman, who never met a company he couldn't fix.

—Frank Voehl

Contents

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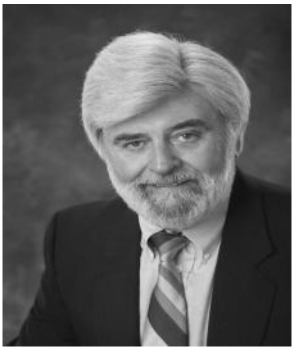

Frank Voehl was certified as a Grand Master Black Belt in Lean Six Sigma and Organizational Excellence Senior Counselor in process and innovation performance excellence, Lean Six Sigma, design for Six Sigma, Lean manufacturing, problem solving, accelerated performance improvement, and policy deployment.

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Hal Wiggin is a Certified Six Sigma Master Black Belt who has been involved in government and agency organizational development and process improvement activities for over 30 years. He was the director of Planning and Quality Improvement for the Broward Children's Services Council and regional manager of Performance and Planning for the Florida Department of Children and Families. He was a senior examiner for the Florida Sterling (Baldrige) Council. He started his career as a mental health counselor and school psychologist before completing a doctoral program in educational leadership. He is a planner, trainer, and quality improvement professional. Besides Lean Six Sigma, he has specific expertise in strategic planning, measurement systems, situational leadership, coaching, and group facilitation. He is currently helping Nova Southeastern University develop and implement a new Lean Six Sigma program. He is an adjunct assistant professor in the College of Osteopathic Medicine and he consults in health care, government, and other industries.

1

Introduction to Lean Management

> Our organization is a mirror of our management beliefs. Lean management can only be achieved by those that understand, believe, and practice Lean leadership.
>
> **Richard Charron**

> Lean without management is a pipe dream; management without Lean is bad dream.
>
> **Frank Voehl**

IN A NUTSHELL

In a Lean organization, management typically has two functions: maintaining or controlling existing processes, and improving existing processes. Regardless of where you stand on the road to being a Lean organization, many companies today operate within some form of risk-management or cost-containment philosophy that addresses the maintenance-control function of management. In this environment, managers are faced with control of asset management, resource management, and risk management, while concurrently being charged with improving organizational performance: performance management. Performance management, the primary focus of a Lean organization, occurs through continuous improvement programs that focus on education, socio-technical (belief systems) development, and effective change management. This chapter presents the basics that encompass Lean management and leadership in two critical areas: maintenance/control and improvement.

Company examples are used in this chapter to present and discuss the strengths and weaknesses of Lean management thinking. The interactions between asset, risk, and resource management are constantly being weighed against performance management or process improvement. For example, a look at this organizational struggle between maintenance and improvement can be evidenced from the in-depth studies in the food and farming industry in the United Kingdom. On the basis of a case study of red meat supply, it is argued that the adoption of Lean practices internally may be appropriate for all participants in the industry, but the inter-organizational aspects of Lean may not be easy to apply in practice, nor appropriate for many participants. For some participants—especially the multiple retailers—the adoption of Lean principles may lead to a positive outcome with stable and/or increasing profitability. For the majority of participants in this industry's supply chains, however, the adoption of Lean principles may result in a high level of dependency on buyers and to low or declining levels of profitability, unless the entire value chain is integrated using a Lean management system.

The remainder of this handbook expounds on these basic concepts and builds a road map for deploying a Lean management system first across your organization, and subsequently across your entire value stream.

OVERVIEW

In the literature, Lean is almost exclusively described as a set of waste identification and elimination tools. It is almost as if these tools can be applied in a vacuum without the need for sound Lean management to go along with the process improvement initiatives. "Just use these tools and productivity will jump and your organization will be Lean." Currently, there is a focus shift toward developing a *Lean Company Culture*. Organizations have discovered that management's role in process improvement is crucial to success. Our view described throughout this handbook is that education, social systems, and Lean change management skills are intertwined and inextricably merged. Organizational improvement initiatives will achieve little success without a focus on these three critical areas. Their synergistic absence in the literature is so profound that finding a suitable definition of *Lean Management* was a challenge. The authors arrived at the following two definitions only after significant discussion.

Definition

1. A fusion of Japanese and U.S. management principles focusing on the reduction of waste, inventory, and customer response time.
2. A systematic and very focused approach for guiding employee learning, education, and practice of Lean principles and philosophies across an enterprise. Lean management encompasses both an individual and a collective organizational transformation plan for the deployment of a Lean educational system, Lean sociotechnical system (belief system), and Lean change management system.

> We built trust early on with our team members. GM had problems selling the Nova in 1987 to '88, and they substantially cut the orders to our plant. We had to reduce production and were running at about 75 percent capacity, but we didn't lay anybody off. We put people on Kaizen teams and found other useful tasks for them. Of all the things we did at NUMMI, these did the most to establish trust.
>
> **Dennis Cuneo, Senior VP of Toyota Motor Manufacturing North America Toyota**[1]

America Toyota values and tries to maintain mutual trust, because it is the foundation for the growth of the company and its employees. Toyota realizes this kind of mutual trust is not a given condition between the management and the employees. It must be earned through many mutual efforts to create confidence.[2]

Dawn of Lean Manufacturing

John Krafcik was a researcher at Massachusetts Institute of Technology (MIT) in the late 1980s to early 1990s and is credited with coining the term *Lean manufacturing*. Krafcik at that time had been involved in a study of best practices in automobile manufacture when the MIT study provided a focus on the methodology developed at Japanese auto giant Toyota under the direction of production engineer, Taiichi Ohno. As we all know, the end of World War II saw Toyota as needing to improve brand image and market share, and Ohno reputedly turned to Henry Ford's

classic book, *Today and Tomorrow** for inspiration. One of Ford's guiding principles had been the elimination of waste (the Japanese word for waste is *muda*). Ohno identified seven basic wastes (*the 7Ws*): defects, overproduction, waiting, transporting, movement, inappropriate processing, and inventory.

Porsche and the Lean Transformation

Today, many companies of various shapes and sizes have realized significant gains by implementing a Lean management system similar to that of Ford's original concepts. The Lean alternative is to align functions and departments with the lines of the value stream, ensuring that both the work cells and the assets are dedicated to performing certain tasks. By using this approach, unnecessary and nonvalue-adding activities can be forever removed from the system, leading to a more efficient and effective process. An example of an automotive company that has adopted the Ford Lean management principles is Porsche AG, the famous sports car manufacturer.

Their Lean initiative was started in the early 1990s and spanned a 5-year period, during which Porsche doubled its fundamental productivity levels in operations while cutting defects in supplier parts by 90% and first-time-through errors in-house assembly by more than 50%. By 1997, Porsche had launched two products using a Lean approach after only 3 years of development work, which was an exceptional effort at that time. The three primary results of this effort were the following: (1) to cut the needed manufacturing space in half, (2) to shorten lead times from raw materials to finished vehicle from 6 weeks to 3 days, and (3) to cut parts inventories by 90% (Table 1.1).

* This is a truly outstanding breakthrough book for those in manufacturing who are starting out on their Lean management journey. The book teaches the uninitiated that Henry Ford was an original thinker in the unique way that he had of recognizing *waste* in manufacturing, and often, how to deal with that waste. Taiichi Ohno took a *boatload* supply of this book with him to Japan in the 1950s and made sure that every Toyota engineer read the entire book from cover to cover. The rest is history as to how Toyota *copycatted* and packaged up this information for the rest of the world, including the United States, in its now famous *7 wastes of manufacturing*. You will enjoy the book and learn what an outstanding visionary Henry Ford truly was, and why he is known as the *Father of Lean Management*.

TABLE 1.1

Porsche Results

	1991	1993	1995	1997
Time				
1. Concept to launch	7 years	—	—	3 years
2. Welding to finished car	6 weeks	—	5 days	3 days
Inventories	17.0	4.2	4.2	3.2
Effort	120	95	76	45
Errors				
1. Supplied parts	10,000	4,000	1,000	100
2. Off the assembly line	100	60	45	25

The aforementioned Porsche Lean deployment example attempts to give an indication into the results that can be attained when a company is committed to a systematic and standardized approach to Lean management. Regardless of company type (manufacturing or service organization) or market sector (public, private, nonprofit, or government), or industry (healthcare, energy, auto, etc.), the role of management has four primary aspects: (1) performance management, (2) risk management, (3) asset management, and (4) resource management. This is how management organizes the company to add value for its customers and dictates the level of financial success the company will achieve. Figure 1.1 illustrates that an effective Lean management system cuts across all of these management areas and in fact establishes a foundation upon which to build your Lean management system.

In this handbook, we present and discuss a standardized Lean management system structure that allows management to fulfill its dual role of process maintenance (control) and process improvement. As with all organizations, management roles in a Lean management system vary with employee level. Figure 1.2 shows Lean management system structure by employee level and primary role. It illustrates that all levels of the organizations must be cognizant of their respective dual roles to manage both process maintenance/control activities and process improvement activities. More importantly, it defines the Lean focus that is essential for the successful deployment of a Lean management system.

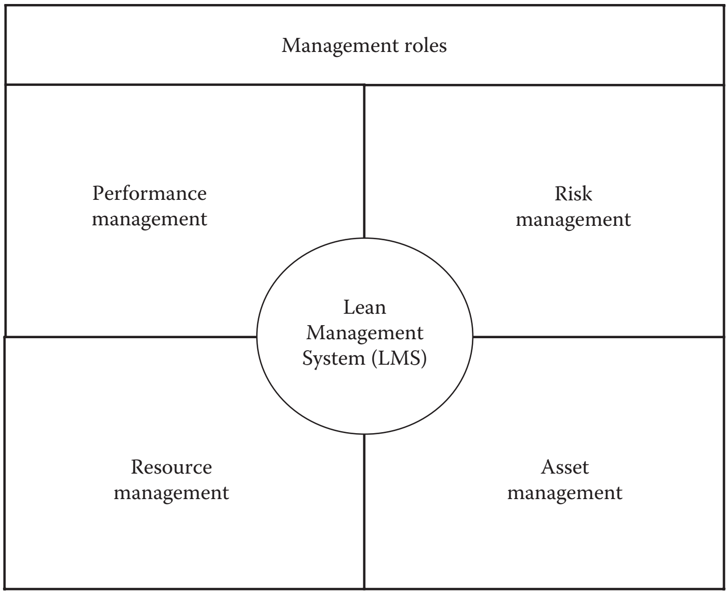

FIGURE 1.1
This figure depicts the four integrated management roles in a LMS, and while it is shown one-dimensionally, the actual diagram is a 3-D cube with the various roles constantly shifting, as in a Rubik's Cube.

		Dual Lean Management		
Employee Level	**Primary Role**	**Maintenance Control Activities**	**Improvement Activities**	**Lean Focus**
Senior management	Lean vision and values	Asset management Resource management	Eliminate waste Mura (variation)	Policy management (education, beliefs, change management)
Middle management	Define and lead operational change initiatives	Risk management Performance management	Muri (things that are hard)	Value stream management
Front-line managers	Deploy initiatives		Muda (waste)	Lean tools deployment

FIGURE 1.2
This figure is a table showing the 16 components involved in a LMS.

PERFORMANCE MANAGEMENT

To achieve Lean performance benefits, management must adopt Lean business drivers and align resources to pursue these business drivers. The principles of Lean management thinking can be defined in terms of the contributions of each of the following five key concepts*:

1. *Value:* Value is always the central focus and critical starting point for Lean management thinking. The key point here is that value can only be defined by the ultimate customer, and it is truly meaningful when expressed in terms of a specific product that meets all the customer's needs and wants.
2. *Value stream management:* The value stream is an integrated set of all specific actions required by the organization to bring a specific product through the following three critical management tasks of any business: (1) product development management—all problem-solving tasks running from concept through detailed design and engineering to production launch, (2) information management—all tasks touching information management from product conception to product delivery, and (3) operations management—all physical transformation tasks proceeding from raw materials to a finished product in the hands of the customer.
3. *Flow*†*:* With value precisely specified, the value stream for a specific product fully mapped by the Lean enterprise, and wasteful steps eliminated, it is time for the next step in Lean management thinking—make the remaining value-creating steps flow. Instead of having activities performed by distinctive departments, all of the

* James Womack; *Lean Thinking*. In this work, Womack defined a series of business drivers required for the successful deployment of a Lean enterprise.

† In their breakthrough book on *Lean Thinking*, authors James Womack and Daniel Jones outlined Lean thinking in terms of focusing on clearly specifying *value*, lining up all the value-creating activities along a *value stream* while making value *flow* smoothly at the *pull* of the customer in pursuit of *perfection*. Following these deceptively simple concepts, many people struggle on the path of becoming Lean because they constantly get stuck in the muck and the mire of waste, status quo, and egocentric leadership. For example, look at just the concept of flow, which sounds easy enough to understand. Most of us know what is meant by flow and what is not. Flow is going down the turnpike or highway at full speed with little or no traffic, whereas getting stuck in a bumper-to-bumper traffic jam is not flow. The authors cover how do we make value *flow* more smoothly, and introduce us to the six flows in manufacturing, which include the following: (1) flow of raw material, (2) WIP, (3) finished goods, (4) flow of operators in relation to the flow of machines, (5) flow of information, and (6) flow of engineering.

activities pertaining to the completion of a product or service should be organized in a single, uninterrupted flow.

4. *Pull:* Once a company has placed its revenue-generating assets in the pathways of the flow concept, the next step is to start making product only when there is an actual demand from a customer, rather than working against a forecast. This concept is called pull and ensures that none of the eight areas of waste are being created, or at the very least minimized.
5. *Pursuit of perfection:* The continued pursuit of the first four business drivers, along with a laser-beam focus on customer requirements (or creating new value for the customer), is a continuously evolving challenge for most organizations, whether they are Lean or not. The ability to strive for perfection from the customer's standpoint is the basis of the continuous improvement process.

To truly comprehend, we must first observe each of the following flows to gain full understanding. In our observation, we encourage our clients and students to take notes and sketch out the six flows as they see them. It is very important not to skip this step and actually sketch out the six flows regardless of our artistic skills. Why do you think it is important for us to sketch them? As we are sketching the six flows, what are some of the things we should be observing? To help us think more of flow, here are some of the key things to look for while in the *gemba* workplace.

Raw Material, Work-in-Process, and Finished Goods Flow

How do we define what the standard work really is? What are the locations and distances between them? What are the various container types and sizes? How about a definition of the packaging materials and what workers do with it? Are there any machine cycle times to be concerned with? If so, how is the transfer of material accomplished, what are the conveyors, carts, forklifts being used?

Operator Flow in Relation to Machines

What are the standard work and the fundamental operator cycle times that determine the pace of the line, slowest to fastest? What are the

operator's body movements covering arms, hands, head, eyes, legs, and feet? Observe the *go-gets and go-tos* of operators and staff getting things to do their tasks. What are the machine cycle time and set-up requirements of the machines? What is the machine process and is it right sized for what is required and only for that job? Are there unused or excessive features in the machine? Name the steps required to operate the machine, and the requirements of properly maintaining the machines. Are the machines purchased or self-built in-house? Take time to observe the machine wastes, collection, disposal, size and shape, recycle coolant, and so forth.

Information Flow

Take the time to observe the transfer of information, and observe what information is needed. What is the path of information, and what are the decisions made by the operator? How many decisions? What does the operator do when a problem occurs or if he or she has a problem or question? How does information concerning problems get passed along? Who responds to the operator's needs, and what information is on production control boards, production schedules, Kanbans, manufacturing plans, and so forth?

Engineering Flow

What is the tooling required? What are the process controls and quality checks? Are there *go/no-go* gauges? Observe any hanedashi devices (the mechanisms to automatically eject a part from the machine to free up the operator to only load the machine).

In each of the six flows described previously, observe the stops, the hesitations, the delays, and the redos. We should also consider all six flows working in harmony to improve the flow. From these detailed observations of the flows and our gained understanding of the process, we will begin to see how to make value flow smoothly.

Figure 1.3 shows the connection between our Lean management system and Womack's five business drivers.

The benefits of this approach are lower working capital because of reduction of work-in-process (WIP) inventories, the ability to respond to shifts in customer demands, and in some cases, lower capital requirements (space, machines, etc.).

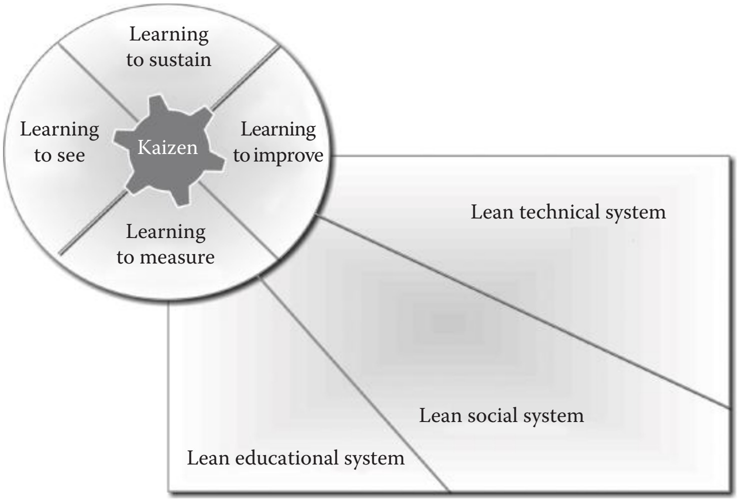

FIGURE 1.3
The Lean management model.

ASSET MANAGEMENT

In our Organizational Excellence series, the *Resource Management Excellence* book addresses the role of asset management as follows: *we must manage our resources and assets because they are what drive our business results.** Companies and organizations depend on vital assets to drive their business; however, they often see them as individual, standalone objects operating in the background. In reality, companies comprise a collection of strategic assets that are tightly interdependent and exist as a single system that should be managed as a unified enterprise at higher levels in the organization. Lean management can also have a dramatic positive impact on the performance of fixed, physical, or capital assets that have a direct and significant impact on achieving corporate objectives.

The Lean aspect of asset management strives to maximize asset performance for the lowest total cost of ownership while taking into account risk, safety and compliance, and management with a limited set of resources.

* See the Organizational Excellence series, originally published by Paton Press. Dr. H. James Harrington wrote all five books in the series, and was assisted by Frank Voehl on the knowledge management and process management books, and by Thomas McNellis on the project management book.

To get continuous-flow systems to flow for more than a minute or two at a time, every machine/asset must be completely *capable*. That is, they must always be in proper condition to run precisely when needed and every part made must be exactly right. The reliability of the assets is the responsibility of the maintenance department who are responsible for the asset management function. Strategic asset management helps companies to maximize the asset reliability and performance required for a Lean manufacturing implementation.

A bicycle-manufacturing example can illustrate the importance of proper asset management by considering the implications of machine breakdown with unplanned downtime. On a given morning, the operator of the tube-bending machine is scheduled to bend 100 aluminum tubes and finds out that the electric motor of the machine does not start anymore. The maintenance department was behind in their preventive maintenance program and the motor had missed a few badly needed revision tasks. Luckily for the operator, all of the tube-bending machines are located in the tube-bending department, and some of the newer machines have multisize tube-bending capabilities. So, the operator informs the maintenance department of the problem and moves the production batch to the other tube-bending machine and completes the job. Furthermore, these bended tubes are only necessary for the production run of the week after next, so even in case the machine that broke down was the only one that could perform the required task, there was ample time for the operator to get the maintenance department to perform a rush job.

RESOURCE MANAGEMENT

Let us continue with our example from our case study of the bicycle manufacturing company to further explain the transformation to a Lean management enterprise. The key functional blocks of activities in the bicycle manufacturing process are (1) tube cutting, (2) tube bending, (3) mitering, (4) welding, (5) washing and painting of the frame and handle bars, and (6) final assembly of the completed bike. Most traditional manufacturing companies have organized their production layout along the lines that are very similar to these functional groupings (Figure 1.4).

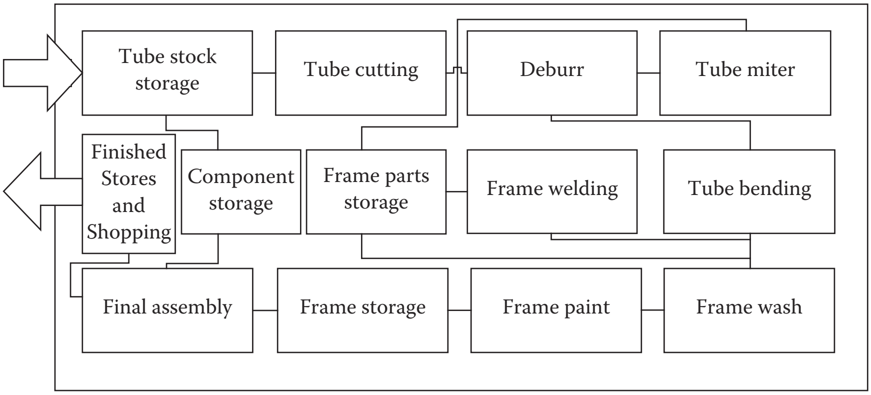

FIGURE 1.4
Layout of traditional bike manufacturing plant.

For each stage of manufacturing, machine automation has been introduced to remove manual labor from the process. Because changeover times on these machines were lengthy, parts are usually produced in large batches. To manage the production process, a planning system is used, which generates work orders based on a forecast, taking into account the inventories of parts and subassemblies. Because of the large batch sizes for part production, the total lead times for the bikes are usually quite lengthy. In addition, the batch sizes also lead to high inventories of subassemblies and parts adding to the need for increased working capital.

Cellular Manufacturing

In the continuous-flow layout, the production process is laid out in the sequence of the process steps required to make the bike, removing all non-value-added movements between functional departments (Figure 1.5).

In the new S-Cell flow-oriented layout, single large machines have been replaced or broken into multiple small machines so that bikes can proceed continuously, one at a time, from the subassembly production of tube cutting, mitering, bending, welding, washing, and painting to final assembly without ever stopping. To realize this, changeover times have been reduced using *single minute exchange of die* (SMED); takt times have been established to manage the flow. Supermarkets have been defined to accommodate both paint cure times and effective response for customer demand for products using pull-based systems. In addition, the size of the work teams can be effectively deployed to meet the relative production volume of the S-Cell.

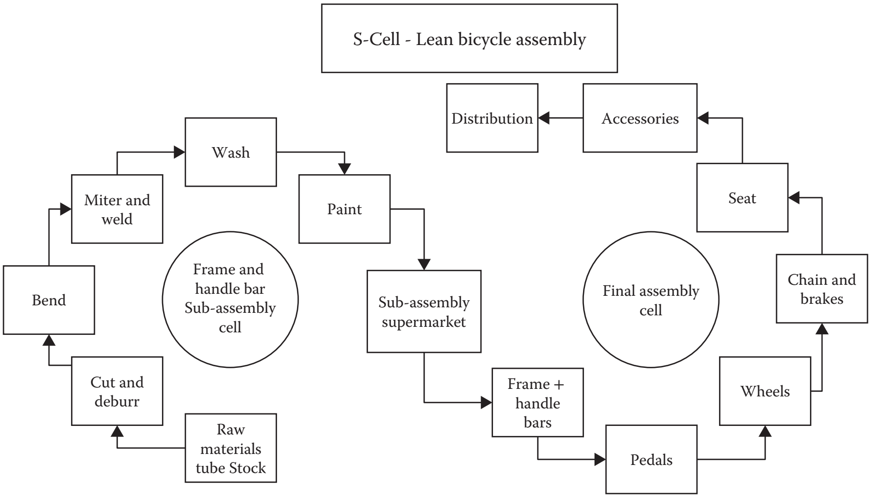

FIGURE 1.5
Layout of Lean bicycle manufacturing plant.

Now that the layout of the bicycle plant has been changed to the flow-oriented S-Cell layout, the impact of the breakdown has changed significantly. The tube-bending machine is placed *in-Cell*. A breakdown of the tube-bending machine therefore affects the production output of the entire line. More importantly, because the planning system has been changed from forecast-based production with production of parts in advance to pull-based production based on demand signals, the impact of a breakdown is that a real customer demand cannot be fulfilled. The reliability of the tube-bending machine becomes a critical prerequisite for the performance of the entire production line for aluminum bikes.

Maintenance departments need to put in place programs that help improve and manage the reliability of the critical assets. To achieve this, maintenance departments must master a set of core competencies that are related to the asset management function and put in place the required improvement programs. Strategic asset management provides maintenance and asset managers with a framework to make decisions on improvement programs and to make the right decisions in relation to the corporate objectives.

Within Lean management's strategic asset methodology, companies can deploy individual techniques. These include (1) total productive maintenance, (2) reliability-centered maintenance to increase the asset reliability, (3) just-in-time (JIT) or vendor managed inventories to manage

their parts inventories, and (4) activity-based costing or zero-based budgeting to improve their understanding of costs.* A Lean management system directly affects the ability of the company to achieve the following corporate objectives:

- Revenue protection and enhancements through higher asset reliability
- Cost control and reduction through enterprise visibility of maintenance activities across sites and asset classes
- Risk mitigation and legal compliance through the implementation of standard-based work processes and common standards for safety and health-related processes
- Competitive advantage through better execution and lower cost for maximum performance

While implementing a strategic asset management program requires people that have the right skills and experience, the investment in a software solution to support the strategic asset management program can provide the following significant benefits:

- Decreasing the number of systems required—one system across all asset classes and geographies
- Reduction of total cost of ownership
- Reduction of number of integration points
- Visibility of performance of assets and workforce using a common set of standards for benchmarking
- Flexibility to adjust the solution to changing requirements and work processes
- Embedded best practices leading to easy adoption by the users

RISK MANAGEMENT

An easy way to explain the impact of Lean management on the risk profile of the company is to think in terms of insurance. If you consider

* Time not being used effectively is a universal form of waste in all of the systems referenced. Ohno looked at the reasons for machines or operators being underutilized and set about addressing them all.

the buffer stock as a type of insurance policy that can reduce the risk that a customer order cannot be shipped and the implementation of the Lean principles drives the company to remove these buffer stocks, then the risk of nondelivery increases. The company needs to take out another insurance policy in the form of more reliable assets that help to mitigate this risk. Strategic asset management helps companies to implement better asset management programs that help to increase asset reliability.

Asset management combined with Lean management principles provides a framework for improving the reliability of assets that are interdependent. Companies can evaluate when to apply specific maintenance philosophies and techniques and can keep the total cost of ownership and life-cycle cost to a minimum. Not only does such a methodology lead to better maintenance practices, but it also provides organizations with critical information that will help them reach their greater business goals.

LEAN MANAGEMENT SYSTEM DEPLOYMENT MODEL

The deployment of Lean over the years has been approached in many ways. This section presents and recommends a systematic Lean Management System Deployment Model. This model program can be targeted at both manufacturing and government, along with various service-sector organizations and nonprofits, to initiate a culture of Lean management within organizations looking to get ahead of the competition and reduce inventory at the same time.* Lean objectives and teams are identified and then work proceeds on *live* projects within the business over a 6-month period. Projects are presented to senior management and the wider workforce (Figure 1.6).

Lean Performance Management

Within our Lean programs, we suggest the concentration of strategic activity on financial business performance using some form of Lean

* Taiichi Ohno was also influenced by the way shoppers in the United States were then beginning to purchase products from supermarket shelves, using a "take what's needed, when it's needed" approach. His response to this observation became known in the West as JIT.

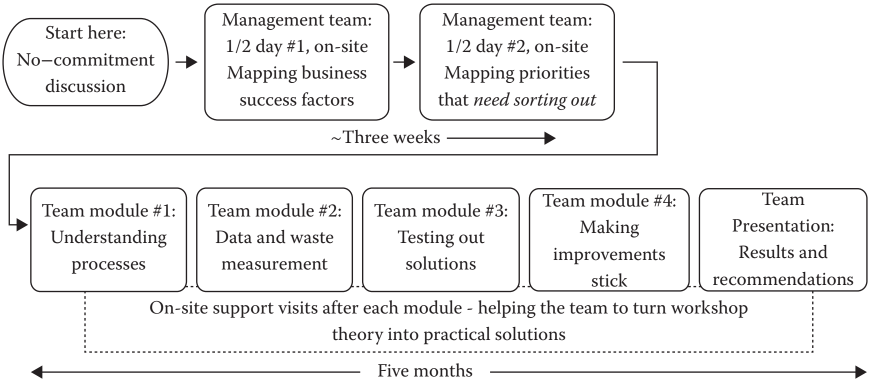

FIGURE 1.6
Lean management program launch.

Management Toolkit.* We look at the value stream from the finance perspective and link operational costs to your financial reporting systems. One of the main financial objectives of Lean management is to bring together Lean with *Finance* to facilitate more effective board-level decision making. Working with middle managers, this is a 6-month program with practical work-based activities designed to develop Lean supervisory and Lean junior management skills. This program develops management skills together with process improvement skills to provide participants with a development route built upon the experience they gain in undertaking the work-based activities. The program culminates in individual presentations to their senior managers on activities undertaken and achievements made (Figure 1.7).

Lean Workers Cross-Training

Within a Lean work system, the practice of job rotation serves the purpose of cross-training and increased flexibility. This can be deliberate and time-based for repetitive manual work, such that people switch from one task to another every 2 hours or when a natural break occurs during

* Our Lean Management Toolkit is written for Lean operational managers, environmental practitioners, and Lean practitioners who work toward organizational efforts to identify and eliminate organizational waste, rework, and delays, to name a few. As a result, the toolkit may help align your management system's goals and objectives as a routine task of your Lean initiatives and business decisions. The toolkit focuses on the identification and how to pursue high-value operational end points in your processes through Kaizen events, 6S (5S + Safety), and value stream mapping. This toolkit is a living document whose future versions may also pursue other Lean practices. In the meantime, the authors welcome your comments and reflections on this document, as well as other ideas you have for Lean and Six Sigma strategies, tools, and resources, which can be incorporated in future versions of the toolkit.

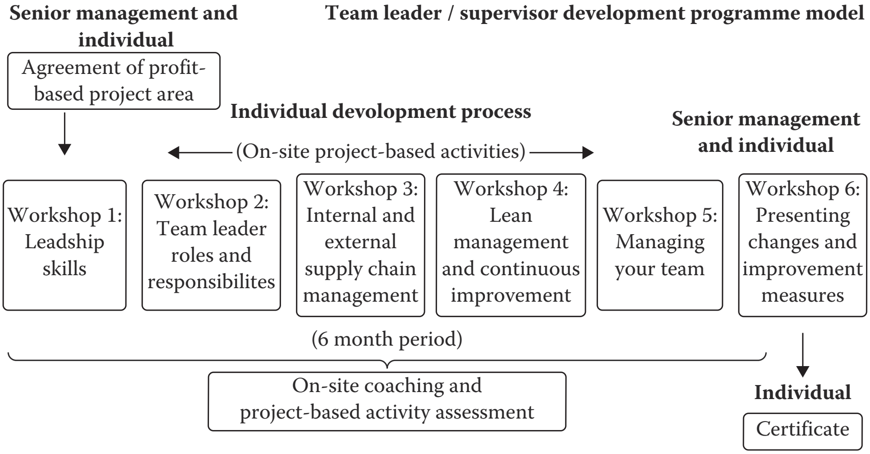

FIGURE 1.7
Lean management leadership program training.

the work day. As the work moves away from the physical and repetitive toward transactional, abstract, or knowledge-based, it becomes harder to build the cross-training within a work day, but it can and should be done, as arguably the benefits are far greater. At the other extreme, leadership development is aimed at creating successors within an organization by giving less experienced managers increasingly larger responsibilities, but cross-training in this regard is often done on an ad hoc basis or not at all.

The introduction of a trainee into a process is often a cause for nervousness on the part of the new person. The new trainee is unfamiliar with the work, rarely has enough time to prepare, and will make mistakes. Being exposed comes with a certain degree of discomfort for most people. People do not like to expose their weaknesses, especially if they have been working successfully in a different job or process for a long time. Recognizing that there will always be an initial gap between desired and actual performance within a new job, the best way to view problems in cross-training or learning a new job is to see the factors that make the job hard to learn as opportunities for Kaizen. The problem is with the process, not with the person.

Cross-training helps to expose problems with the process such as difficult working conditions, vague standards and work instructions, or incapable processes that require that people develop a feel or knack to perform properly. As different people attempt to do the job properly and fail, these hidden problems are quickly surfaced and can lead to Kaizen. Promoting cross-training and job rotation can be a great way to breathe life back into

the Kaizen efforts within a mature Lean operation. Even when there is not a clear business case to cross-train people, bringing in a finance person to do an engineer's job reveals problems that lurk beneath the water.

We can view cross-training as a way to test the hypotheses that processes are set up robustly enough to allow a new person to quickly get up to speed. Of course the majority of jobs will fail this process, the more so the further we move from simple, visible, and physical processes. Although we cannot spend all of our day willfully experimenting while on the job, if both the trainee and the trainer keep a *learner's mindset*, good things will happen, beyond finding Kaizen opportunities in the process itself.

When problems with cross-training are identified and addressed, this helps to build mutual trust between supervisor and worker, trainer, and trainee. This basic level of security that concerns will be heard and addressed is essential as a foundation of a high-performance workplace. At the same time, this trust creates an opportunity for the trainer to point out weaknesses or knowledge and skill gaps in the trainee. Ideally the trainer would also recognize the Training Within Industry adage "when the student hasn't learned, the teacher hasn't taught" and improve based on constructive criticism from self and others.

As people work together in training around a process, we can also gain deeper understanding about ourselves in terms of how we interact with the process, people, and the learning environment. The *Johari window* is useful in framing these situations. The Johari window is a tool of cognitive psychology created by Joseph Luft and Harrington Ingham to help people improve their interpersonal communication and relationships. The four panes of the window represent knowns and unknowns by oneself and by others. The typical Johari exercise involves placing a set of 56 words that describe one's behaviors in the four panes, and the act of cross-training can be a more dynamic and on-the-job version of such an exercise (Figure 1.8).

The idea within the Johari window concept is to increase the size of the *open* section of the window, creating greater understanding between people by reducing the unknowns. This requires curiosity, courage, and a sense of purpose whether it be solving a problem or increasing one's level of skill. Becoming aware of one's own blind spots through help from others, as well as understanding one's motives for keeping certain things hidden can also be avenues for growth. The Johari window is also effective as an enabler of job rotation, cross-training, and Kaizen.

This need for cross-training grounded in self-awareness, mutual trust, and understanding is a topic that has importance beyond doing Kaizen

FIGURE 1.8
The Lean management Johari window.

better and enabling Lean operations. Recent unemployment statistics in the United States imply that while jobs are being created, many of the people who are jobless do not have the skills needed to fill these jobs. This is a problem both for the employer and the person seeking the job, a limiter to economic growth and prosperity. At the organizational level, we need to do as much as possible to promote cross-training. Applying the Johari window idea to the macro level, how well do we understand the open areas of our economy, the jobs that are being created versus the skills needed and available? And how aware are we of the hidden or unknown areas of our economy that have led to recent problems but also present future areas for growth? The opportunities to use this metaphorical window are many, most immediately with ourselves and our colleagues.

Change Management for Senior Management Teams

This is designed for each company, but begins with an initial appraisal of the organization and how it is dealing with its competitive environment. Psychometric testing is often used to help managers understand more about their leadership styles and approaches to managing others. A series

of workshops can then be delivered to address the practical problems of translating strategy into meaningful actions and then the motivating and performance management of change projects that involve the wider workforce. We always seek to run this program alongside a real change project to allow managers to put new skills into practice. Programs can vary in duration according to client needs.*

In-House Lean Deployment Projects

Developed specifically for individual companies to deliver process improvement targets linked to business objectives. Typical projects will focus on reducing lead times, improving quality, improving performance to customers, generating more capacity, and improving workplace organization. Most of these projects involve more than one project area and aim to deliver sustainable change to working practices and behaviors. What has become described as *changing the company culture*.

Toyota Lean Management System Explained

Taizo Ishida (1888–1979) took over the role of president of Toyota from the inventor and founder Kiichiro Toyoda in the midst of labor unrest, layoffs, and the threat of bankruptcy. Ishida is considered the *restorer of Toyota* for good reason in that his business acumen, leadership, and what would later be called Lean values helped bring Toyota out of its crisis. Ishida shares his secrets of success in the book *The 7 Principles of Toyota's Business Success*. These seven principles are as follows:

1. Establish industry leaders with Japanese minds and skills. In this phrase, we see a strong desire to contribute to a positive Japanese trade balance with the world, as well as to develop the nation's industrial capability. Replace *industry* with your type of business,

* One common theme from the Lean management playbook is called the knowing-doing gap. Popularized by Stanford University Professor Robert Sutton, the knowing-doing gap plagues so many organizations full of intelligent, dedicated people who make insufficient or ineffective practical use of their knowledge, training, black belts, and shared understanding of what should be done. Toyota worldwide. Mr. Kato worked closely with both Taiichi Ohno and Shigeo Shingo in the early days when TPS was being built up. He has written a new book with Art Smalley titled *Toyota Kaizen Methods*, which is highly recommended.

institution, or economic sector and *Japanese* with the people of your own region and you can steal this secret of strong long-term purpose tied to community.

2. Employ good thinking, good products—creativity and craft. Both of these phrases can be seen with Toyota to this day, unchanged. They have survived for 60 years because they are timeless, pithy, and proven to deliver results. Toyota's business origins were in invention (the automatic loom), a good product from good thinking, without the element of *overproduction*.* The name of Toyota's Kaizen suggestion system is the *creativity and craft* system, which Toyota stole from Ford in 1951. In principle or in practice, this is a success secret every organization should own.
3. Cultivate a spirit of *countrified* people. There may be a note of local pride or even defiance here, as the region of Toyota's origin was rural and far from the financial, intellectual, or economic center of Japan. No doubt, the rural values of hard work, resourcefulness, and the lack of unnecessary cultural sophistication in running a successful manufacturing business were a part of this principle. The harried treasure hunter leaves behind what looks suspiciously like large lump of coal. The savvy treasure hunter steals this huge gem.
4. Adopt an indomitable fighting spirit—willpower. Steal this if you can, beg or borrow it if you cannot, but make it yours and do not give it back. Fight to the finish and win!
5. Create organizational and individual self-reliance. The principle of self-reliance is consistent with the spirit of rural work ethic, strengthening Japanese industry and Ishida's renowned frugality. This frugality was strengthened by the humiliation Ishida suffered at the hands of Japanese bankers during his early days as president when Toyota nearly went out of business. Ishida did not hesitate to invest in equipment to make more money, as long as the money was not the bank's. "Defend your own castle" was a famous saying of Ishida. Let us go with "Rob your own bank" on this one.
6. Employ a joint effort. We can say "all for one and one for all" as the catch phrase that best reflects this Toyota business secret. Unless

* A key element was making only the quantity required of any component or product. Another Toyota engineer who contributed to this change was Shigeo Shingo who led the move long machine tool setups to SMED. The simplest form of waste is components or products that do not meet the specification. The key point came with the switch from quality control to quality assurance—efforts devoted to getting the process right, rather than inspecting the results.

principle 1 was misplaced shortly after being stolen, this principle should just be a question of leadership maintaining focus.

7. Develop people. Last on the list but primary in importance, steal this principle early and often, as it tends to slip through our fingers like a thin silver chain.

Ishida was a humble man who said that he was only temporarily holding the seat of the president until Kiichiro Toyoda returned to that role. He also said that he was channeling old man Toyoda when he set out these principles, carrying on the founder's vision rather than setting out to make a name for himself. His advice was widely sought by leaders of Japanese industrial giants. Ishida deserves great credit for reviving Toyota at a critical moment in its history, securing a firm foundation of values and principles and insisting on zero tolerance of waste.*

To learn more about the early days of Toyota and the influence of Ishida on the development of the Toyota way, we recommend *Inside the Mind of Toyota: Management Principles for Enduring Growth* by Satoshi Hino. To the leader who would dare steal the seven secrets of Toyota's business success, let it be known that these are not treasures to be hidden away but to be shared openly with any and all who would steal them from you.

Taiichi Ohno likened the Toyota Production System (TPS) to establishing an autonomic nervous system within the factory.† Just as we viscerally react to signs of danger to withdraw our bodies from danger

* Note that Womack and Jones, the leaders of the MIT Study, suggested an eighth waste: *designing and making products, which do not meet the customer's requirements*, though this could perhaps be classified within Ohno's inappropriate processing.

† Lean management and the brain according to Ohno. Within the three to four pounds of spongy flesh that is called the human brain, there are 1 trillion cells, more than 100 billion neurons, and 10 × 10 to the millionth power of possible neuron connections, numbers that can make your brain have pain. Modern research describes the human brain as having three main functions: regulation, learning, and selection. According to Ohno and others, the parallels to a Lean management are direct and appropriate as the primary function of the brain is regulation of the body. The brain inhibits or excites various bodily functions, controls actions, and manages various starts and stops. A series of simple chemical on–off signals at the level of neurons combine in a staggering number of ways to allow us to do everything from dance the jig to dig up buried civilizations. Lean management in a manufacturing environment at one level is a production control system that stops overproduction and starts production based on customer pull. Signals are simple and local, green lights for go and red for stop.

or respond to stimuli even without being conscious of doing so, Lean manufacturing establishes systems that are intended to cause similar responses. The downstream pull or Kanban system is one example; the Andon and problem response system is another. This fundamental shift from a conscious command-based production control approach to a subconscious stimulus-based production control system is another parallel between Lean manufacturing and the brain.

As in Lean learning, the second function of the brain is accomplished by making new circuits and connections between the 100 billion neurons. Learning and forgetting happens as the degree of repetition strengthens or weakens these connections. Accordingly, Lean flow requires that we set up experiments and learn by constantly changing for the better. There is no finished state in the Lean flow, only the current state, the unattainable ideal condition, and the drive toward it. This drive toward the unattainable helps us to keep learning, while sustaining a Lean flow system requires learning from our mistakes and solving problems.

As in the third function of selection, the brain references from memory those experiences that have worked out well or not so well in the past to consciously guide our actions, which are often described as our guiding principles, values, or even human wisdom. We choose to select good over bad, better over good, value over waste. In Lean manufacturing terms, this is the practice of reflection on the human brain's conscious comparison and reasoning through what is working and what is not. Another way to think of this is the closing of the feedback loop of continuous improvement, the act–plan component of the plan–do–check–act cycle. Even in a pull-based Lean business model, decisions do not make themselves, but the structure of a Lean system can make it difficult or even impossible to make bad decisions in certain cases. This is the essence of mistake proofing, limiting capacity or space to create WIP, and disconnecting automation or software that drives overproduction in favor of reactive systems that are based on proven principles, such as pull.

Kaizen is the act of making small changes in the physical world so that we learn to improve, learn to make better choices, and to build and regulate better processes. When a person learns an instrument, a language, or nearly any skill, it is the wiring together of some of the 100 billion neurons as a result of repetition that results in mastery. This is why Kaizen, or repeated small steps toward improvement, is so important. The primary

resource for Kaizen is human brains.* As with the 100 billion neurons with their 10 × 10 to the millionth possibilities, in a Lean flow everything is connected and everything keeps changing. The traditional direction of improvement is to isolate, stabilize, and shield from risk. Unfortunately, no situation is ever completely stable and disconnecting parts of the system to buffer or minimize risk sometimes, more than not, removes stimuli; and a lack of stimuli unwires our neurons in the brain, and likewise when we improve by covering up problems in the organizational flow, we are learning to manage in the wrong manner.

Lean Management and Green Revolution

In response to the surging demand for Lean management, the U.S. Environmental Protection Agency (EPA) developed a Lean and Energy Toolkit to assist organizations in reducing energy use and improving performance through Lean manufacturing—the production system developed by Toyota.† Drawing from the experiences and best practices of multiple industry and government partners, this toolkit describes practical strategies and techniques to improve energy and environmental performance while achieving Lean goals such as improved quality, reduced waste, and increased customer responsiveness.

There are three reasons for integrating Lean and energy efficiency efforts:‡

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* It is one of the ironies of Lean management thinking that when you think you understand and are doing Lean, you are not. When you are pretty sure you do not understand it yet but are doing your best, you are getting close. This can make teaching Lean to people who *understand* already very difficult sometimes. Learning requires doing and people resist what they perceive as redoing to be a denial of their past successes. The potential energy of the untapped knowledge in the minds of people within an organization is huge. Turning the potential energy into kinetic energy requires releasing one's grip on what we hold in our minds and letting it drop to the floor where it can do some good.

† See the Harrington Institute's Lean Management Toolkit for some common tools and methods.

‡ EPA's Lean and Environment Initiative has developed a series of toolkits that offer practical techniques and strategies to help Lean, environmental, and other specialists on the shop-floor identify and eliminate waste. These toolkits draw heavily from the experience of organizations that have pioneered integrated approaches to Lean and environmental decision making while at the same time delivering world-class performance, exerting market leadership, and achieving bottom line results. Use the tabs above to begin exploring the toolkits. Written for Lean operational managers, environmental practitioners, and Lean practitioners, the hope is that these toolkits will help organizations to identify and eliminate environmental wastes. They may also help align your environmental management systems goals and objectives as a routine part of your Lean initiatives and business decisions.

1. *Cost savings:* Reducing energy costs has a significant impact on business performance, though costs may be hidden in overhead or facility accounts.
2. *Climate change and environmental risk:* Proactively addressing the environmental and climate impacts of energy use is increasingly important to industry and society. Failure to do so is a potential business risk.
3. *Competitive advantage:* Lowering recurring operating costs, improving staff morale, and responding to customer expectations for environmental performance and energy efficiency increase your competitive advantage.

Considerable energy savings typically ride the coattails of Lean activities because of Lean's focus on eliminating nonvalue-added activities (waste). Without explicit consideration of energy wastes, however, Lean may overlook significant opportunities to improve performance and reduce costs. Companies such as Baxter International, Eastman Kodak, IBM, General Electric, Toyota, 3M, and many smaller manufacturers have successfully used Lean flow methods to reduce energy use, risks, and costs.*

SUMMARY

In this chapter, we introduce the two primary responsibilities of Lean management: maintaining and improving existing processes. We define a Lean management system as one in which managers have four fundamental areas of responsibility: risk management, asset management, resource management, and performance management. Risk, asset, and resource management are typically referred to as the maintenance or control complements, while (Lean) management is typically referred to as the improvement portion of management responsibilities.

* A few of the methods discussed in this handbook are contained in mini-case studies and profiles, three of which are summarized here: (1) A Baxter International facility saved $300,000 in energy costs in 1 year, (2) General Electric has reduced greenhouse gas emissions by 250,000 metric tons and saved $70 million in energy costs since 2005 at facilities worldwide, (3) Toyota Motor Manufacturing North America reduced facility energy use and greenhouse gas emissions by 30% per vehicle since 2000.

We present and discuss some of the fundamental drivers and requirements for Lean management system. We describe the importance of establishing flow for all your products and services using examples where applicable. The description of the bicycle manufacturing plant before and after cellular manufacturing implementation documents the importance of developing flow.

We present the fundamentals of a Lean Management System Deployment Model that describes educational requirements and the necessity for employee cross-training. We describe the concept of the Johari window, which underscores that Lean education creates a greater common vision and understanding of how to apply Lean concepts in your organization. In the chapters that follow in this handbook, we will describe the many aspects and requirements for a sustainable Lean management system.

REFERENCES

1. Jeffrey K. Liker, *The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer*, McGraw-Hill, New York, 2004.
2. Michael A. Husar, "White Paper, Corporate Culture: Toyota's Secret Competitive Advantage," p. 11, May 15, 1991.

2

History of Lean

IN A NUTSHELL

Lean is a relatively recent term used to describe manufacturing process improvement activities and has only been in existence for approximately the past 30 years or so. The need to improve manufacturing processes, however, goes back thousands of years. In this chapter, we present some examples of how process improvement techniques have been applied throughout history. From the Venetian shipbuilders' frame-first approach to Henry Ford's production line and subsequently to Taiichi Ohno's waste-free manufacturing, we review the evolution of manufacturing process improvement.

OVERVIEW

Lean started with the first start-up company that was underfunded. Entrepreneurs learned early in business life how to run a Lean organization. When you do not have money to spend, you do away with everything that is not essential, that is, the very reason why Henry Ford Sr. was the first person to set up a Lean mass production line.

But Lean is a complicated methodology that had many tools added to the basic methodology as it matured. We liken it to a new home. When you first get married and move in to your new home, you have just the essentials—a TV, a couch, a bed, and one set of dishes. By the time you reach your 40th wedding anniversary, you have collected enough things to fill every nook and cranny of the house. You have a vase that you bought on your trip to Spain, the Lladro that you bought in England,

the glass that you bought in Venice, and the handwoven rug from India. You also have pictures of your three children and grandchildren, a library of books and video tapes, and all the different decorations for each of the holidays and more. This is what has happened to Lean; it started out as a concept of eliminating waste, and the possible ways of doing it continue to grow to this day. It now includes every consultant's idea of a way to sell his or her services.

LEAN TECHNIQUES

The following are just some of the most used Lean concepts and tools:

- Four P's: philosophy, people, process, and problem solving
- Minimization of non-value-added activities
- Waste identification and elimination
- Continuous flow manufacturing concepts
- Just-in-time principles
- Quick changeover
- Setup time reduction
- Documentation and use of standard operating procedures
- Use of visual displays for workflow and communication
- Total productive maintenance
- Error proofing
- Techniques to prevent or detect errors
- Suggestion systems
- Principles of motion study and material handling
- Systems for workplace organization (the *5S* approach)
- A large number of continuous improvement methods
- Value stream mapping/flowcharting
- Small lot principles

Source: Quality Council of Indiana.[1]

Waste not, want not.

Source unknown

There are many examples of the use of Lean concepts dating back to before the birth of Christ because everyone, but the rare exception, hates

to waste his or her time, money, and/or resources. Can you do it faster, better, and less expensive has always been the driving force that has led us out of the Stone Age to today's prosperity. The Lean management system captures all of these techniques and merges the key elements with the following:

- A strong but flexible architecture
- Specific application tools
- To form an integrated whole
- That aligns the various parts of an organization
- To make a change of great magnitude*

According to Thomas Jackson, *the development framework* comprises several key components, as shown in Table 2.1:

1. Three cornerstones of growth
2. Nine keys to development
3. Control points
4. Five levels of organizational learning

VENETIAN ARSENAL (1104–1800)

Looking back in time, one of the best early examples of Lean was the Venetian Arsenal, an organization in Venice that built naval vessels for the Venetian navy. The Venetian Arsenal (Italian: *Arsenale di Venezia*) was a complex of state-owned shipyards and armories clustered together in Venice, northern Italy. Its construction began around 1104 (Wikipedia). Its founder pioneered the concepts of interchangeable parts, use of standardized design, and continuous flow concepts. Their mass production line started by building the frame first; the common practice at the time was to build the hull first. This cut out a lot of waste, made production much faster, and required less wood. They then floated the frame down the narrow channels that moved it to a number of assembly points where major parts of the vessel were added until the ship was complete. This allowed the Venetian Arsenal to build hundreds

* In his description of Lean management systems in his seminal work *Corporate Diagnosis* (Productivity Press, pgs. 9–23), author Thomas Jackson presents a method for systematically measuring the success of such initiatives as part of an organization's company-wide improvement process.

TABLE 2.1

Introduction to the Lean Management Scorecard

Cornerstones of Growth	Keys to Development	Control Points
Strategy	Customer focus	Customer requirements, relationships, and order to delivery
	Leadership	Business renewal, goal focus, standardization and adherence, reflection, and dialogue
	Culture of improvement	5S and standardization, waste-free strategy, technology diffusion, education, and learning
Structure	Lean organization	Team-building activities, networked organization, rewards and recognition, suggestions, evaluation and compensation, Lean administration
	Partnering	Employee value, comakership, environmental impacts, social integrity
	Information architecture	Visual controls and workplace organization, fast-feedback systems, performance measurement, Kaizen reporting
Strengths	Lean fulfillment/ production	Continuous flow, multiprocess handling, leveled/mixed model prod., quick changeover, automation with human touch, pull system/coupled production, fulfillment scheduling
	Lean equipment management	Equipment/process improvement, autonomous/quality maintenance, early equipment management, safety, equipment investment/maintenance design
	Lean design (engineering)	Design for Six Sigma process, design for Six Sigma outputs

Note: As shown in this example of a Lean management scorecard, the three cornerstones of growth are coupled with the nine keys to development to form a structure tree diagram with the control points forming the basis of measurement.[a]

[a] In his description of Lean management systems in his seminal work, *Corporate Diagnosis*[2] (Productivity Press, p. 16), author Thomas Jackson presents a method for systematically measuring the success of such initiatives as part of an organization's company-wide improvement process.

of galleys every year. As time passed they continued to focus on improving the processes, until by the sixteenth century they were able to complete an entire galley in less than 1 hour.

TABLE 2.2

Evolution and Development of the Lean Keys to Growth

Date	Contributor	Contribution	Lean Keys to Growth
1104–1800	Venetian Arsenal	Continuous flow manufacturing Mass production line	Customer focus, leadership, culture of improvement, Lean organization, information architecture, Lean fulfillment/production, Lean design (engineering)
1792–1805	Eli Whitney	*Manufactory*/process flow Interchangeable parts	Customer focus, leadership, culture of improvement, Lean organization, Lean fulfillment/production, Lean equipment management
1772–1851	Eli Terry	Interchangeable parts for mass production (1814)	Customer focus, leadership, Lean fulfillment/production, Lean equipment management, Lean design (engineering)
1856–1915	Frederick W. Taylor	Scientific management (1890s) Time study Work standards Documentation of process	Leadership, culture of improvement, partnering, information architecture, lean equipment management
1896	National Cash Register Company	Culture of continuous improvement Suggestion system	Customer focus, culture of improvement, partnering, information architecture, Lean equipment management
1868–1924	Frank and Lillian Gilbreth	Process charts Work simplification Motion studies One best way	Customer focus, leadership, culture of improvement, information architecture, lean fulfillment/production, lean design (engineering)
1863–1947	Henry Ford Sr.	Mass Production Line (1910) Just in time Supplier controls Profit sharing Error proofing Anyone can stop the line Quick changeover Reduced cycle time In Line Quality Inspectors	Customer focus, leadership, culture of improvement, Lean organization, partnering, Lean fulfillment/production, Lean equipment management, Lean design (engineering)

(*Continued*)

TABLE 2.2 (*Continued*)

Evolution and Development of the Lean Keys to Growth

Date	Contributor	Contribution	Lean Keys to Growth
1887–1944	Charles Bedaux	Rating assessments Timing work Value analysis	Culture of improvement, information architecture, Lean fulfillment/production, Lean design (engineering)
1891–1967	Walter L. Shewhart	Control charts (1924) Plan–do–check–act (1939)	Culture of improvement, information architecture, Lean design (engineering)
1893–1976	Harold F. Dodge and Henry Romig	Sampling tables	Culture of improvement, information architecture
1943–Today	Japan/ Japanese Union of Scientists and Engineers	Japanese management systems Deming Prize for Quality Process benchmarking	Customer focus, leadership, culture of improvement, Lean organization, partnering, Information architecture, Lean fulfillment/production, Lean equipment management, Lean design (engineering)
1915–1989	Kaoru Ishikawa	Quality circles (1948) Fishbone diagram Company-wide TQC (CWTQC)	Customer focus, Leadership, Culture of improvement, Lean organization, partnering, information architecture, Lean fulfillment/production, Lean equipment management, Lean design (engineering)
1922–Today	Armand V. Feigenbaum	Total quality control concepts (1951); CWTQC; quality cost	Customer focus, leadership, culture of improvement Lean fulfillment/production, Lean design (engineering)
1912–1990	Taiichi Ohno and Shigeo Shingo	Toyota Production System (TPS) Just in time Removal of non value added Quick changeover Total productive maintenance Error proofing/Poke-Yoka 5S, Kanban, small lots	Customer focus, leadership, culture of improvement, Lean organization, information architecture, Lean fulfillment/production, Lean equipment management, Lean design (engineering)

TABLE 2.2 (*Continued*)

Evolution and Development of the Lean Keys to Growth

Date	Contributor	Contribution	Lean Keys to Growth
1926–2001	Phil Crosby	ZD approach (1961) Four absolutes	Customer focus, leadership, culture of improvement, Lean fulfillment/production, Lean equipment management, Lean design
1947–Present	JUSE	Process Benchmarking	Defining best practices Lean design Process improvement
1904–2008	Joseph Juran	The Juran Trilogy The Pareto principle Managerial breakthrough	Customer focus, leadership, culture of improvement, Lean fulfillment/production, Lean design (engineering)
1928–Present	Yoji Akao	QFD Policy deployment	Customer focus, information architecture, Lean fulfillment/production, Lean design (engineering)
1979–1985	IBM's approach to quality improvement	Internal benchmarking (1970) Process qualification (1980) Process improvement management (1983) Fast Action Solution Technique (FAST)	Customer focus, leadership, culture of improvement, information architecture, Lean fulfillment/production, Lean design (engineering)
1900–1993	W. Edwards Deming	The 14 points Profound knowledge PDCA/PDSA	Customer focus, leadership, culture of improvement, information architecture, Lean fulfillment/production, Lean design (engineering)
1983	U.S. government	TQM (1983); organizational change management; comprehensive quality training for everyone	Customer focus, leadership, culture of improvement, Lean organization, Lean fulfillment/production, Lean equipment management, Lean design (engineering)
1948–Today	Eliyahu M. Goldratt	Theory of constraints (1984)	Customer focus, culture of improvement, Lean fulfillment/production, Lean equipment management, Lean design (engineering)

(*Continued*)

TABLE 2.2 (*Continued*)

Evolution and Development of the Lean Keys to Growth

Date	Contributor	Contribution	Lean Keys to Growth
1987	Malcom Baldrige Performance Excellence Program	Malcolm Baldrige National Quality Award	Customer focus, leadership, culture of improvement, information architecture, Lean fulfillment/production, Lean design
1929–1993	Bill Smith	Six Sigma (1987)	Customer focus, leadership, culture of improvement, information architecture, Lean design (Design for Six Sigma [DFSS])
1929–Today	H. James Harrington	Business process improvement Business process management Total Improvement Management Value-added assessments Streamlined process improvement Process redesign	Leadership, Lean organization, partnering, Lean fulfillment/production, Lean equipment management, Lean design (engineering) Process Redesign Strategic Planning Value-Added Analysis
1988	John Krafcik	Coined the term Lean Production System	Lean fulfillment/production, Lean equipment management, Lean design (engineering)
1992	GE	DMAIC (1992)	Customer focus, leadership, culture of improvement, Lean organization, information architecture, Lean fulfillment/production, Lean equipment management, Lean design (engineering)
1993	Hammer and Champy	Process reengineering the corporation (1993)	Leadership, culture of improvement, Lean fulfillment/production, Lean design (engineering)
1994	Frank Voehl	The house of total quality The quality journey Supplier, inputs, process, outputs, customers/ SIFOC	Customer focus, leadership, culture of improvement, Lean organization, Lean fulfillment/production, Lean design (DFSS)

TABLE 2.2 (*Continued*)

Evolution and Development of the Lean Keys to Growth

Date	Contributor	Contribution	Lean Keys to Growth
1998	Jeffery Liker	*The Toyota Way* narratives on the application of the TPS	Culture of improvement, Lean organization, Lean fulfillment/production, Lean equipment management, Lean design (engineering)
2002	Michael L. George	Coined the term Lean Six Sigma (2002)	Customer focus, leadership, culture of improvement, Lean organization, Lean fulfillment/production, Lean equipment management, Lean design (engineering)
2014	Charron, Voehl, Harrington, and Wiggin	House of Lean management as a system	Customer focus, leadership, culture of improvement, lean organization, partnering, information architecture, Lean fulfillment/production, Lean equipment management, Lean design (engineering)

Note: As Table 2.2 shows, the Lean keys to growth have evolved over the past 1000 years or so, with a particular acceleration having occurred during the past 100 years. In many cases, each of the Lean growth spurts has been energized by an innovative individual or a recognized mastermind of some kind. Each successive era shows Lean growth progress, giving meaning to the expression "standing upon the shoulders of the giants who have come before us."

ELI WHITNEY (1792–1805)

Eli Whitney (Figure 2.1) is falsely credited as the person who implemented interchangeable parts in the production line in the United States. The truth of the matter is that around 1778 Honore Blanc was able to produce firearms with interchangeable parts. He showed this ability in front of a committee of scientists where he assembled a musket out of a random selection of parts.

Whitney, who invented the cotton gin in 1793, recognized the potential for developing interchangeable parts for firearms that were used by the U.S. military. As a result, in 1798 he built 10 guns, all containing

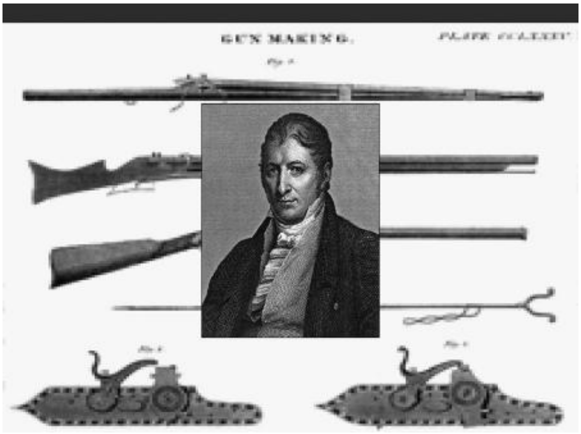

FIGURE 2.1
Eli Whitney.

essentially the same exact parts and mechanisms. He disassembled these guns in front of the U.S. Congress, mixed the parts up in a large pile, and reassembled them right in front of Congress. This so impressed Congress that they gave Whitney a production order for 10,000 muskets at $13.40 each. In reality, the 10 muskets that Whitney used were all fashioned by highly trained experts and Whitney was never able to design a manufacturing process that was capable of producing the same accuracy allowing gun parts to be interchangeable. The drawback with Whitney's guns was that their quality was much lower than those made by hand. The choice between quality and quantity was made in favor of quantity.

ELI TERRY (1772–1852)

The first mass production using interchangeable parts was Eli Terry's Pillar-and-Scroll clock, produced in Plymouth, Connecticut, in 1814. This clock was made out of wooden parts, and producing interchangeable parts out of metal proved to be a much more difficult situation. The development of interchangeable parts was an essential element in establishing the continuous flow production line, which is a key ingredient in Lean (Figure 2.1).

FREDERICK W. TAYLOR (1856–1915)

The next major breakthrough in Lean was made by Frederick W. Taylor (Figure 2.2), who documented his ideas in his book entitled *The Principles of Scientific Management*. Taylor developed four principles of scientific management. They are as follows:

1. Development of a true science
2. Scientific selection of the workman
3. Scientific education and development of the workman
4. Intimate and friendly cooperation between management and the workman

Taylor believed that there was only one best method of work that would maximize the efficiency and effectiveness of an operation. He stated that this one best method and best implementation can be developed only through scientific study and analysis. Prior to Taylor's work, employees developed their own methods that best suited their own personalities. Taylor introduced the standardization of work methods. As a result, he created a planning department staffed with engineers and gave them the following responsibilities:

FIGURE 2.2
Frederick Taylor.

1. Develop scientific methods for doing work.
2. Establish goals for productivity.
3. Establish systems of rewards for meeting goals.
4. Train the personnel in how to use the methods and thereby meet the goals.

Taylor's work resulted in the following:

- Time and motion studies
- Work standards
- Equipment standardization
- Improved management communication systems

He was the first to recognize the management's risk in making changes and its impact on the culture of the organization.

Frederick Taylor was born on March 20, 1856 and is known as the father of scientific management and efficiency movement. He was the first management consultant. In 1893, Taylor opened an independent consulting practice in Philadelphia, Pennsylvania, under the theme of systematizing shop management and minimizing manufacturing costs as his specialty. Taylor believed that the best results would be achieved only through a partnership between a qualified, trained management team and an involved, cooperative workforce. Taylor is most remembered for his development of the time and motion study. He would break jobs down into their component parts and measure each of them to the hundredth of a minute. A great deal of his work was done at Bethlehem Steel, Bethlehem, Pennsylvania, where he was generally unsuccessful in applying his methods and was later dismissed. But this was the start of an evolutionary and revolutionary way of viewing the way work was performed and how waste was defined in manufacturing processes.

FRANK GILBRETH (1895–1924)

Frank and Lillian Gilbreth were associated with Frederick Taylor, but there was a major philosophical difference between them. Whereas Taylor's stopwatch mentality was focused on reducing process time, Gilbreth was focused on reducing motion involvement. Frank Gilbreth

reduced all motions of the hand into a combination of 17 different motions. To study individuals performing a task, he used a motion picture camera that was calibrated in fractions of seconds so that he could pick up the smallest of changes in worker habits. He used micromotion studies to record and examine detailed, short-cycle movements as well as inventing cyclographs and chrono-cycle graphs to observe the rhythm and movements. Some of his early work was with bricklaying; after studying bricklaying, he determined that there were 18 motions per brick and was eventually able to reduce it to 5 motions. The number of bricks per hour that could be laid increased from 175 to 350, and productivity went up to 200%.

Another example was the time taken to stamp order cards. When it was done originally, the workers could do 1900 cards per hour. When Gilbreth's principles were applied, the figure jumped to 3050, that is, a 37.7% improvement.

Frank and Lillian Gilbreth also focused on material flow through the organization to minimize movement between activities. They coined the term motion studies to show that their field of research was very different from Taylor's time studies. They studied the work habits of manufacturing and clerical employees in many different types of industries to increase output and make their job easier for the employees.

The Gilbreths (Figure 2.3) had a very large family of 12 children who served as guinea pigs for much of their observations. The Gilbreths were

FIGURE 2.3
F. B. Gilbreth and family.

the originators of the idea of eliminating waste, which is a key ingredient in the Lean methodology.

The real difference between Taylor's approach and the approach of the Gilbreths is that Taylor's approach is directed at direct labor and machines with a focus on setting work standards, whereas the Gilbreths' approach looked at defining wasted motion, which is more operationally focused. The Gilbreths are credited with the invention of flowcharts. They constructed sets of charts with new-type symbols that were actually the first process maps.

NATIONAL CASH REGISTER COMPANY (1896)

In 1896, the National Cash Register Company focused on the elimination of waste by introducing the concept of suggestion systems. This effort was directed at getting their employees more involved in improving the organization's performance and recognizing them for doing it. Employee involvement is a key part of any Lean project.

HENRY FORD SR. (1863–1947)

Henry Ford (Figure 2.4) was in complete agreement with the Gilbreths' belief that the average working person very much wanted to provide a fair day's work for a fair day's pay but was often prevented from doing so because of poor design of their workplace and the work itself. As a result, Ford empowered all workers to stop the line whenever they had a significant problem. Ford's basic concept was to share his profits with the customers and his employees. He continuously decreased prices while increasing wages, which in turn generated even greater profit. Ford's Five-Dollar-A-Day salary was nothing more than a profit-sharing plan. Ford's employees were paid significantly more than other people doing similar work activities. This provided him with the choice of the cream of the crop as people were clamoring to come to work for him.

Ford's approach to Lean was not just limited to the manufacturing area; it also applied to finance. Typically, suppliers were paid for their products

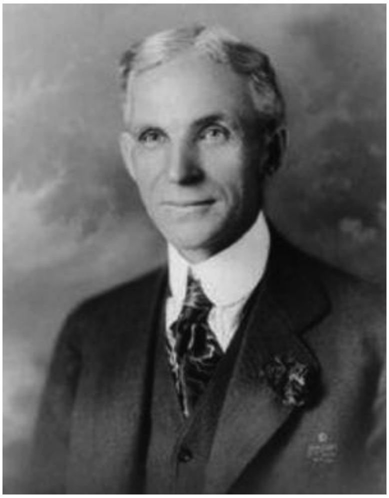

FIGURE 2.4
Henry Ford Sr.

25 days after the receipt of material at the plant. The manufacturing cycle was less than a week, and shipping took another week. Payment terms at the dealers were cash on delivery. The result was that the money from the sale of a car was in the bank a week before the payment for the parts that went into it was due. The system at Ford resulted in a complete turn of inventory throughout the entire plant every few days, a record that no automotive assembly plant can match today. Truly, just in time was practiced at its ultimate degree (Figure 2.5).

Early in setting up his production facility, Ford realized that he had two options. One was to keep the cars stationary and move the assembly workers to the cars, and the other was to keep the assembly workers stationary while the automobiles move through the plant. Initially, he started with the car being stationary and the subassemblies and assemblies moving from worker to worker. This ended up in capabilities to flood the final assembly area with far more assemblies than they could handle. As their team looked for ways to eliminate waste from the final assembly process, they noticed the following:

- Waste in scatter movement of workers
- Waste in searching, comparing, and finding objects
- Waste in conveying objects
- Waste in storing objects

FIGURE 2.5
Ford production line.

As a result, the team came up with the concept of mounting cars in a row that could be pulled along by a rope and a wench. This caused the following to occur:

- They set up a large wench and a thick rope to pull the cars along the assembly.
- The assembly line was divided into 15 process steps; this allowed the rope to be pulled along every hour to the next process.
- Parts were assigned to each of the 15 process areas in keeping with the work that was being performed in that area.
- Three or four workers were assigned to each process area to balance out the labor in preparing the car during that portion of the assembly.

The change was very successful as it reduced chassis assembly time from 12 hours to less than 3 hours. It is interesting to note that the assembly line concept was the result of watching a moving conveyor of carcasses in a Chicago slaughterhouse.

Some of the key features of Ford's production system were the following:

- Quality inspectors
- Continuous flow

- Supplier control
- Workload balancing
- Profit sharing
- Production control
- Error proofing
- Employee improvement
- Employees can stop the line

Ford's approaches were effective in many different production lines. For example, during World War II his Willow Run Bomber plane built a B-24 bomber every 55 minutes. This bomber was made up of over 1.25 million parts. The average car has only 15,000 parts in it.

In 1926, Henry Ford's book *Today and Tomorrow* was published; it contained most of the concepts used in the Lean methodology. It provided the basics for today's Toyota manufacturing system. This book is a must read for anyone who is using or going to use Lean approaches (Figure 2.6).

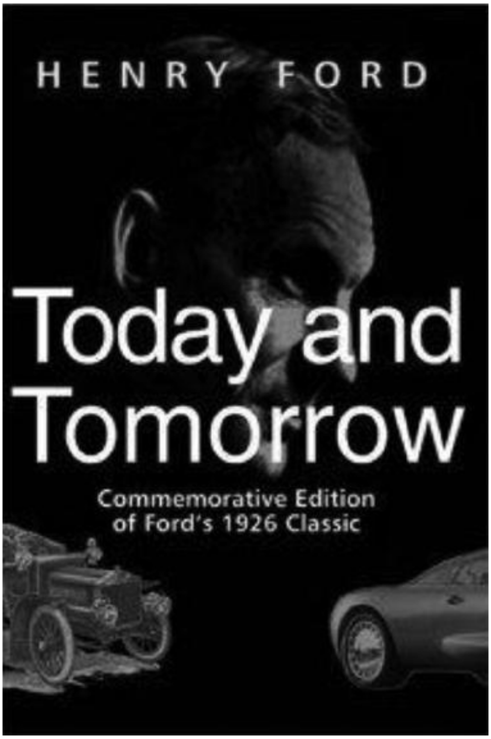

FIGURE 2.6
Henry Ford's book *Today and Tomorrow*.

CHARLES BEDAUX (1887–1944)

With Taylor's scientific management, Ford's continuous flow production line, and Gilbreths' work on motion studies, the focus on eliminating waste grew in momentum. In 1916 Charles Bedaux picked up Taylor's work after Taylor died, and he had a widespread influence in the United States and Europe. Bedaux introduced the concept of rating assessments and timing work. His work included introducing the concept of value analysis.

WALTER L. SHEWHART (1891–1967)

The next major breakthrough occurred in May 1924 when Walter L. Shewhart (Figure 2.7), the father of statistical quality control, prepared a little memo—only about a page in length. Approximately one-third of that page contained a simple diagram, which we would all recognize today as a schematic control chart. The control chart was developed to reduce the amount of 100% inspection waste that was going on at the Bell Telephone Company (later renamed as AT&T).

FIGURE 2.7
Walter Shewhart.

In 1939, he also created the Shewhart cycle for waste reduction. It included four stages:

1. Plan—identifying what can be improved and what changes are needed
2. Do—implementing the designed change
3. Check—measuring and analyzing the process or outcome
4. Act—if the results are not as hoped for

Later, Edwards Deming restructured the Shewhart cycle to the plan–do–check–act (PDCA) cycle. Sounds like the same cycle? We can safely say that while Shewhart invented the approach, Deming became its salesman.

HAROLD F. DODGE (1893–1976) AND HENRY ROMIG (1893–1972)

A major quality breakthrough occurred between 1941 and 1944 from the Bell System, and this was the result of the work done by Harold F. Dodge and Henry Romig. The Dodge–Romig sampling tables simplified the statistics of quality sampling to the point that they could be used effectively by nonstatisticians, and they have served as the basis of our present sampling plans. They are best known for work in originating acceptance sampling plans for putting inspection operations on a scientific basis in terms of controllable risks. Again, this focused on reducing the waste in doing 100% inspection.

HENRY FORD II (1917–1987)

In 1946, when Henry Ford II took over the management of the Ford company, his family brought in General Motors' experienced management team and the market share/cash flow goals were replaced with the objective of maximizing return on investment. Almost immediately, Lean manufacturing was done away with throughout the Ford company.

KAORU ISHIKAWA (1915–1989)

In the early 1950s, there was an ongoing flow of quality consultants who were invited to Japan to teach quality methods. For example, W. Edwards Deming visited Japan in 1950, Joe M. Juran went in 1954, and Armand V. Feigenbaum went in about 1957. Feigenbaum's book, *Total Quality Control* (published in 1951), was discovered in the early 1950s in Japan and had a major impact on the Japanese quality systems.

With all the focus on quality and the many new concepts that were being introduced, Dr. Ishikawa felt that there needed to be a way to provide the needed information to the people at the working levels (Figure 2.8). As a result, Dr. Ishikawa created the concept of quality circles (quality control circles) in 1949. The purposes of the quality circle were the following:

- Educate and train in the workplace employees in techniques related to quality improvement.
- Support the improvement and development of the company.
- Draw out employee potential.
- Increase job satisfaction.
- Empower workers.

FIGURE 2.8
Kaoru Ishikawa.

He believed that quality must be a company-wide activity, including products, service, management, and the company itself, as well as its people. His efforts focused on eliminating waste at the work team level.

ARMAND V. FEIGENBAUM (1922–PRESENT)

Armand V. ("Val") Feigenbaum's 1951 book, *Total Quality Control*, helped reshape the way companies viewed quality management, causing a *quality revolution* that swept through companies around the world during the 1970s and 1980s (Figure 2.9).

In the early 1950s, Feigenbaum and his team at the General Electric (GE) Company developed a quality cost system. As a result of their work, a number of new terms became part of the quality professional's vocabulary, terms such as preventive cost, appraisal cost, internal failure cost, and external failure cost. These new terms allowed quality professionals to communicate in dollars the cost of waste in the organization, a language that top management understood. It was first described by Feigenbaum in a 1956 *Harvard Business Review* article.

FIGURE 2.9
Armand V. Feigenbaum.

TAIICHI OHNO (1912–1990)

Following World War II, Toyota was faced with a major problem regarding how to rebuild their shattered manufacturing base, lacking a huge market or economy-of-scale advantages available in U.S. companies. They were also faced with major credit restrictions imposed on them by the occupying forces. As a result, Toyota was nearly bankrupt when Ohno took on the task of redesigning production. At that time, he was the company's assembly shop manager. Based on these limitations, he focused on three basic rules:

1. Build only what is needed.
2. Eliminate anything that does not add value.
3. Stop if something goes wrong.

Ohno is the individual who was the driving force behind establishing today's Toyota manufacturing system.

Lean manufacturing was born at Ford at the turn of the century, and it continued to evolve at Toyota in the last half of the twentieth century. Both companies built their manufacturing processes around the core concepts of quality, flow, and synchronization. Much of the activities that went on within Toyota were directly related to Henry Ford Sr.'s 1926 book *Today and Tomorrow*. Although the Toyota family fully accepted Henry Ford Sr.'s approaches, Ohno wanted to correct two significant weaknesses in Ford's approaches. To correct these weaknesses, Toyota made the following changes:

- Pull production scheduling system using cards
- Increased flexibility

They established a pull production scheduling system through the use of the Kanban or card system. Originally, the Kanban system was implemented in machine operations in 1953. It was finally adapted for ordering parts from outside suppliers in 1965; this was a 12-year gap in which trial and error refined the system to the point that it was effective.

The other flaw in Ford's system that Toyota corrected was the lack of flexibility. Toyota addressed this through just-in-time delivery of parts, small lot sizes, and 1-minute changeover of dyes.

Toyota also coined the phrase 5S, which is the name of a workplace organization methodology that uses a list of five Japanese words, *seiri*, *seiton*, *seiso*, *seiketsu*, and *shitsuke*. The English translations are as follows:

1. *Seiri* (sorting)
2. *Seiton* (straightening or setting in order/stabilize)
3. *Seiso* (sweeping or shining or cleanliness)
4. *Seiketsu* (standardizing)
5. *Shitsuke* (sustaining the discipline or self-discipline)

Although the concepts behind 5S were well known and practical in many organizations, Toyota put them together in an easy-to-remember approach that helped build personal commitment. Toyota's production system is based on two concepts, which are called the two pillars:

- Pillar I: Lean—the total elimination of all non-value-added waste.
- Pillar II: respect for people—when you invest in your most important asset (people), you get the biggest return.

SHIGEO SHINGO (1909–1990)

Shigeo Shingo worked closely with Ohno. His early work was primarily focused on reducing setup time. Much of his work focused on mistake proofing equipment to ensure quality. Dr. Shingo was an ardent student of Gilbreths' work. Dr. Shingo stated that the Toyota system is not a system opposed to the Ford system, but rather it is an enlarged, progression of the Ford system.

Norm Bodek, the author of *The Power and Magic of Lean*, recalls one conversation he had with Dr. Shingo. The group stopped at a press that was forming metal. Dr. Shingo pulled out a stopwatch and watched the operation through one cycle. He asked the following question: "What is the percent of value added to non value added?" One engineer said 100%—the worker was continuously working. Another said that it was 50%, and a third said 30%. Dr. Shingo looked at his watch, laughed, and said, "Only 14% of the time is value added." Dr. Shingo went on to explain his calculation, stating that only when the press is forming the metal is real value added; the rest is waste or non value added. Dr. Shingo stated that the Japanese keep things simple, whereas the Americans make things complex. He went on to state that this explains why the Japanese have thick black hair, whereas the Americans have thin grey hair.

The following are the bakers-dozen key Lean points related to Toyota's Lean production line and to all practitioners of the approach to Lean management systems:*

- Equipment was arranged to follow the process flow.
- The line can be stopped by the workers.
- A detailed study of the individual process and cycle time was conducted.
- Employees were using wait time to run additional machines, changing nonproductive wait time into value added activities.
- Elimination of waste concepts.
- Installed suggestion systems.
- Close working relationship with suppliers.
- Just-in-time concepts.
- In-process inspection by workers.
- Quick changeover with smaller batch sizes.
- Kanban implementation.
- Visual factory.
- The 5S.

PHIL CROSBY (1926–2001)

As the world tried to meet the production demands of the space environment, we were still plagued with design and workmanship problems. As a result, in October 1961 Phil Crosby gave birth to the concept called *zero defects* (ZDs). This concept was really embraced by the military as it served the nation's needs. ZD banners, charts, and even parades swept the defense industry. Contracts were modified to include requirements for ZD programs as they served the short-term needs of eliminating waste and driving close to perfection with the product. Unfortunately, these programs did not supply the long-term motivation to sustain the programs because Crosby's concepts were misused. Quality improvement is not a ZD campaign—it is a long-term commitment, a way of life, a search for excellence to try every-day to not make an error, to personally live each day without making errors.

* The Lean management system captures all of these elements and merges them together seamlessly.

PROCESS BENCHMARKING (1947–PRESENT)

After World War II, Japan's production industry was in disarray. The industry was faced with a major problem of converting over from war equipment to consumer products. They were also faced with the disadvantage of having a reputation for producing cheap, poor-quality products. The occupied forces headed by General McArthur were pushing the Japanese companies to increase quality and productivity. Hundreds of benchmarking study teams toured the United States and Europe, collecting best practices data. One of our authors hosted many of these teams that toured IBM, San Jose, California, to study their quality system. Without exception, these teams were always impressed with how clean the production areas were and how well laid out the individual workstations were. They were also impressed with the education programs that most employees were taking advantage of.

Rank Xerox has been credited with being the first company to develop a formal process benchmarking system. They made it popular when Xerox Corporation Business Products and Systems, Rochester, New York (manufacturing), gave benchmarking much of the credit when they won the Malcolm Baldrige award in 1998. In reality, many organizations had in place very formal benchmarking long before Xerox. For example, IBM began its internal process benchmarking data exchange activities between locations in the early 1960s. To upgrade this benchmarking process, in 1978 IBM released Corporate Manufacturing Instruction 109—*Process Compatibility*. This instruction set a requirement for any process-sensitive product manufactured at different locations to be manufactured using compatible processes. This action was taken because IBM could not afford to have different levels of quality coming out of different locations and they wanted to define and standardize best practices. For example, the Random Access Files were produced in Fujisawa, Japan; Mainz, Germany; and San Jose, California. Every 6 months, teams from the three locations would meet at one of the locations. They would compare at each operation level the time required to set up and perform the task based on the following:

- Yield
- Levels of inventory
- How the tasks were performed

- Equipment used
- Variation in output

The process that was used to implement this corporate instruction was documented in TR02.834, dated December 3, 1979, by H. James Harrington.

Xerox's program took process benchmarking to new dimensions. Benchmarking techniques were applied to areas beyond product processes, such as support processes. Xerox discovered that benchmarking could be used in any area.[3]

JOE JURAN (1904–2008)

In 1951, Joseph M. Juran published his book *Quality Control Handbook*. He was also remembered because he focused on the human dimension of quality management. His trips to Japan in the 1950s had a major impact on the quality movement in Japan. He was well known for promoting the Pareto principle (also known as the 80–20 rule). He referred to it as the "the vital few and the trivial many." In later years, Juran preferred the term "the vital few and the useful many."

YOJI AKAO (1928–PRESENT)

Yoji Akao, along with the late Dr. Shigeru Mizuno, in 1966 developed the concept of Quality Function Deployment (QFD). This links the needs of the customer (end user) with design, development, engineering, manufacturing, and service functions. QFD is a powerful tool used to compare the product to your competitors' products and to understand the interrelationships of the key measurements when used in conjunction with the house of quality. It was first used in Kobe Shipyards in 1972.

IBM's 1980s APPROACH TO QUALITY IMPROVEMENT

As the 1980s started, a new focus on eliminating waste penetrated through IBM. This time, it was directed at all of the support, engineering, and sales areas. John R. Opel, chairman of the board of directors at IBM, stated, "We need a business process that is worthy of respect and is respected. This means a process that can handle today's values and complexities

accurately and effectively—one that is positioned for the future and, therefore, can move forward ahead with the business, not struggle along behind as it has been doing." As a result, IBM released a corporate instruction that required critical business processes to have control methods integrated into them. IBM released a performance improvement corporate directive in 1982. "It was directed at establishing process improvement for critical business processes. The instruction required that each business process be assigned an owner, certified, and classified in one of five categories. The process owner is responsible for organizing process improvement teams that will bring each process up to the first level. Typical business processes are cost estimation, physical inventory management, supplier relations, engineering change implementation, product release, planning and scheduling, accounts receivable, inventory control, payroll, financial planning, fixed assets, and appropriate controls."[4]

Business process improvement was first highlighted in H. James Harrington's book *Excellence—The IBM Way* on page 35; it was published by the American Society for Quality Control in 1988.[5]

IBM listed over 125 different processes that business process improvement techniques should be applied to. The following are the number of processes that were considered major or critical by area:

- Development: 37 processes
- Distribution: 13 processes
- Financial accounting: 19 processes
- Financial planning: 9 processes
- Information systems: 3 processes
- Production control: 16 processes
- Purchasing: 14 processes
- Personnel: 17 processes
- Programming: 5 processes
- Quality: 2 processes

It then developed a methodology that focused on streamlining the process using the following:

- Bureaucracy elimination
- Value-added assessments (real value added, business value added, no value added)
- Duplication elimination

- Simplification
- Cycle-time reduction
- Error proofing
- Standardization
- Automation/computerization/information technology

The business process improvement approach did not reach everyone in IBM as it applied only to the major processes. In keeping with Opel's instructions—"Everyone in IBM has customers, either inside or outside the company, who use the output of his or her job. Only if each person strives for and achieve defect-free work, can we reach our objective of superior quality."

A program called Department Activity Analysis was originated in about 1984. (It was later called Area Activity Analysis.) This methodology aligned the mission statements from the company level all the way down to the natural work team level and defined the processes that consumed more than 10% of the natural work team's resources. For each of these processes, documented agreed-to customer, supplier, and productivity requirements were prepared. These processes were then analyzed to improve quality and reduce waste. This approach set quality and productivity standards for all parts of IBM and focused the support areas to eliminate waste in the white-collar areas.

W. EDWARDS DEMING (1900–1993)

In 1950, W. Edwards Deming traveled to Tokyo to teach statistical methods. He made 18 more trips and is given credit for having a great influence on developing the quality culture in Japan. In fact, he is also frequently referred to as the man who taught the Japanese about quality. In 1983, he introduced Deming's 14 points for management. These 14 management points or concepts have become so widely used that they are now inextricably tied to all things Lean. Concepts such as *constancy of purpose* have evolved into *True North* by Toyota. The concept of *ending the practice of buying on price* has taught us the importance of supply chain quality and corresponding performance measurement system rather than dead cost purchasing practices. The concepts of leadership, driving out employees' fears, and breaking down the barriers between departments to achieve product or service flow and the importance of education and self-development are all critical components of a Lean management system.

TOTAL QUALITY MANAGEMENT (1984)

Around 1984, quality improvement efforts took on a new name: Total Quality Management (TQM). The true source of this name is unknown. Some people claim that it is from a government publication. Others claim that W. Edwards Deming was the first to use it. This concept included all the tools and methodologies that were in Feigenbaum's book, *Total Quality Control*, plus all the new advances that were developed in Japan, Europe, and the United States. It included all the Lean tools used by Toyota and Ford. It also included all the principles defined in ISO 9000. For the first time, it included some of the human factor approaches such as organizational change management and rewards and recognition systems.

ELIYAHU MOSHE GOLDRATT (1947–2011)

In 1984, Eliyahu M. Goldratt published a book, *The Goal: A Process of Ongoing Improvement*. He pointed out that systems and processes are limited in achieving their goals by a very small number of constraints. All processes have at least one constraint. He labeled this condition the Theory of Constraints (TOC). The approach identifies the constraint and then designs the rest of the process around it through a five-step process:

- Step 1. Identify the constraint.
- Step 2. Define how to exploit the constraint.
- Step 3. Align the rest of the process to maximize the effectiveness of the constraint.
- Step 4. Elevate the constraint (make changes to do away with the constraint).
- Step 5. Go back to step 1 to find the new constraint.

FAST ACTION SOLUTION TECHNIQUE (1980)

The Fast Action Solution Technique (FAST) is based on an improvement tool developed at IBM in the mid-1980s. GE refined the approach in the 1990s and called it *Workout*. The Ford Motor Company further developed it under the title RAPID. Today, Capgemini and Ernst & Young extensively use this approach, which they call *Express*, with many clients around the world.

The FAST approach to business process improvement centers around a single 1- or 2-day meeting that identifies the root cause of problems and/or non-value-added activities. Typically, the improvement results from the

FIGURE 2.10
Picking the low-hanging fruit.

FAST approach are reduced cost, improved cycle time, minimization of waste, and decreased error rates achieved within a 30-day period. Hence, we use the term FAST. It is directed at picking the low-hanging fruit (Figure 2.10).[6]

MALCOLM BALDRIGE NATIONAL QUALITY AWARD (1987)

The Malcolm Baldrige National Quality Improvement Act of 1987 was signed into law on August 20, 1987. The American Productivity and Quality Center (chairman: Jack Grayson) and the American Society for Quality (chairman: H. James Harrington) were key groups that pushed it through Congress. The Baldrige program's mission is to improve the competitiveness and performance of U.S. organizations by defining excellent systems and giving out recognition awards for organizations that were analyzed by independent auditors whose total points score was greater than a minimum level for high performing organizations. Awards are given in six categories. They are as follows:

1. Nonprofit/government
2. Healthcare
3. Service
4. Education
5. Small business
6. Manufacturing

BILL SMITH (1929–1993)

In 1987, William J. Weisz, Motorola's chief operating officer, directed that all processes within the company should show a 10-fold improvement within 3 years. This called for a radical change in the way Motorola's processes functioned. To bring about such a drastic change, in 1987 Bill Smith (Figure 2.11), serving as Motorola's vice president and senior quality assurance manager for the Land Mobile Products Sector, developed and implemented what was called the *Six Sigma program*. The program set an objective for all processes to statistically perform at an error rate no greater than 3.4 errors per million opportunities. The real breakthrough in Motorola's approach was that the Six Sigma concept set a performance standard that applied to all processes, not just manufacturing. Bill is considered the father of Six Sigma.

Six Sigma, as it was first defined, was a very statistically oriented methodology containing the following:

- Histogram
- Standard deviation
- *Z* distribution
- *t*Distribution
- Hypothesis testing
- Comparison of means
- Comparison of variances
- Design of experiments introduction
- Single-factor design
- Two-factor design

FIGURE 2.11
Bill Smith.

- Multifactor design
- Fractional design
- Planning experiments
- Process control methods
- Failure mode analysis
- Multivariate analysis
- Chi-square analysis
- Worst-case analysis
- Monte Carlo analysis
- Root sum square analysis

During the following decade, Motorola continued its Six Sigma program while the methodology spread slowly to other organizations. During the mid-1990s, GE latched onto the concept and spent millions of dollars for implementing the program throughout the organization. GE's program expanded from 200 projects in 1995 to over 6000 projects in 1997, which resulted in more than $320 million in savings, all directly attributed to the organization's Six Sigma program. In 1998, GE estimated that its savings was about $750 million. Similar annual savings continued until Jack Welch, the company's chief executive officer, left in 2001. He stated, "Six Sigma has spread like wildfire across the country and it's transformed everything we do." GE is credited with developing Define, Measure, Analyze, Improve, Control (DMAIC), which serves as the foundation for their problem-solving and waste elimination programs. Later, the Six Sigma concepts were modified to focus on process design using Define, Measure, Analyze, Design, Verify (DMADV).

The Six Sigma program also developed a set of new job descriptions and titles. Starting from the lowest level, they are as follows:

- Yellow belt
- Green belt
- Black belt
- Master black belt

Like the TQM approach, Six Sigma's tools and methodology continued to grow over time to include many approaches that were not directly related to its mission of reducing variation. Much of the gains that the Six Sigma teams made were related to removing waste. As a result, the Lean tools became part of the Six Sigma body of knowledge.

H. JAMES HARRINGTON (1929-PRESENT) BUSINESS PROCESS IMPROVEMENT (1988)

H. James Harrington served as a key member of the team which designed the methodologies that were used to bring about drastic improvement to IBM's support processes in the early 1980s called "Business Process Improvement." It was an expansion of the work he did in the 1960s (then called White-Collar Poor-Quality Costs. The White-Collar Poor-Quality Cost approach flowcharted support processes and focused on reducing appraisal costs (bureaucracy, checks and balances) and error cost. The approach was documented in Harrington's book titled *Excellence—The IBM Way*, published in 1988. A detailed description of the process was documented in Harrington's book titled *Business Process Improvement*, published in 1991.[7] The evolution of the methodology was documented in Harrington's book titled *Streamlined Process Improvement*, published in 2012.[8] This approach is sometimes referred to as "Business Process Management." This approach differs from the Process Reengineering Approach that became popular in the 1990s as it focuses on improving the present process by removing no value added and reducing business value added content from the process. The approach used by Harrington focused on Process Redesign versus Process Reengineering.

LEAN MANUFACTURING (1988)

John Krafcik in his 1988 paper "Triumph of the Lean Production System" coined the phrase *Lean Production System*.

In 1990, James Womack authored a book titled *The Machine That Changed the World*. It was a detailed history of automobile manufacturing around the world. It included a new phrase: Lean manufacturing.

MICHAEL L. GEORGE (2002)

By the twenty-first century, the excitement related to Six Sigma had waned because of the time that was required to complete a project and the amount of time it took to train black belts. Six Sigma was accepted in the majority of organizations as a way to cut costs, and within 1 or 2 years the major cutting projects were addressed and there was no justification for full-time people to be assigned to the Six Sigma project. As a result, now organizations are again looking for quick fixes that can be

implemented at little or no cost. In 2002, Michael L. George authored a book titled *Lean Six Sigma: Combining Six Sigma Quality with Lean Production Speed*. Most of the Lean approaches were already defined in the Six Sigma body of knowledge, but George pulled them out into a separate set of approaches that could be used along with the Six Sigma approaches. As a result, Lean Six Sigma has become popular. It is mostly made up of the Lean tools that have been implanted into the Six Sigma body of knowledge and are being applied at the individual or natural work team level. Again, like TQM and Six Sigma, quality professionals who are out to sell their own capabilities or products have distorted the basic Lean concept to the point that it could soon become as complex as TQM. As long as Lean is defined as the removal of waste, almost all of the over 1000 performance improvement tools are candidates to become part of Lean tools/methodologies.

JEFFREY K. LIKER (2012)

Many organizations have tried unsuccessfully to capture the essence of Toyota. In his books on the Toyota way, Liker goes beyond tools and techniques to expose the heart and soul of Toyota. His 14 management principles in *The Toyota Way* are drawn from observing Toyota today. In this work, we clearly see Toyota's understanding and application of many years of Dr. Deming's teachings. If Western companies can apply these concepts thoroughly and completely, Toyota-type results may become more prevalent. In his latest work, *The Toyota Way to Lean Leadership*, the profound nature of leadership development at Toyota is described as a journey of self-development that is alive and evolving at all levels of Toyota every day. Individual success and organizational success are the direct results of a relentless pursuit of self-development and developing others.

LEAN MANAGEMENT SYSTEMS (2014)

It was not long after Lean Six Sigma got under way that organizations realized that having a clean desk, or having a minimal amount of parts in stock, or being able to change dies in 12 minutes was not enough to grow the business and establish a Lean culture within the organization. The time has come for complete Lean management systems.

The truth of the matter is that an organization should not follow the trend of the week but look at the total set of improvement tools/methodologies and select the ones that meet their unique circumstances. In this book, we are going to focus on building a Lean management system. The cultural and managerial aspects of a Lean organization are more important than the actual tools/methodologies that are used. There are as many examples of where Lean concepts were used without producing satisfactory results as there are for Six Sigma or TQM. These failures did not occur because the methodologies were bad. The reason for these failures lies in the way the improvement processes were implemented (Table 2.2).

SUMMARY

Change is the word that best characterizes the nature of modern societies and determines the challenges that managers and leaders face daily. In the reality of rapid technological progress, global communication, and intensified competition, old methods can no longer reach the same results nor can they respond to the fast-changing situation. The success of companies and managers depends on their ability to react to, operate under, and adapt to change, and some of the contributors featured in this chapter argue that the capability to adjust to new conditions quickly is a competitive advantage.

Time cannot be wasted if one wants to be successful, and management of change in a Lean manner needs to be at the table of the everyday plan of a leader. In fact, the successful structuring of change processes requires powerful methods and tools.

Staying competitive requires looking for new ways of reducing costs and increasing the quality of the company's products. Lean thinking was considered to be one potential approach for improving organizational performance. Many authors suggest that this complex, highly integrated system is the reason for Japan's manufacturing effectiveness.

When flexibility seems to be an important issue in today's highly competitive environment, Lean integrated as a complete system in the organization can ensure the company's adaptation. Developed as a production system that eliminated wastes in Toyota's plants in the 1960s and 1970s, Lean management is evolving into a management approach that improves all the processes at each level of an organization.

Lean organizations reexamine their reason for existence on a regular basis and infuse their entire organization with the ideas they develop.

They also stand on the shoulders of giants who have come before them, constantly learning and blending best ideas with their own. To eliminate waste of all kinds, a Lean organization involves its entire workforce in continually improving its fulfillment processes and ultimately redefines its industry by the way that it does things. In fact, the attitude of improvement so permeates these organizations that quantum leaps are a matter of regular occurrence.

Key success factors that enhance the implementation process are identified in this chapter and in subsequent chapters: human resource practices, management style, organizational strategic vision, organizational culture, and external partnerships. Our research outlines the challenges that companies experience when they change their business model toward implementing a new-to-the-company management system–Lean management system concepts.

REFERENCES

1. Quality Council of Indiana, *Six Sigma Primer*, QIC, Terre Haute, IN, 2006.
2. Thomas L. Jackson, *Corporate Diagnosis: Setting the Global Standard for Excellence*, Productivity Press, New York, 1996.
3. H. James Harrington, *High Performance Benchmarking,* McGraw-Hill, New York, 1996.
4. H. James Harrington, *Total Improvement Management,* McGraw-Hill, New York, 1995, p. 74.
5. H. James Harrington, *Excellence—The IBM Way*, McGraw-Hill, New York, 1988.
6. H. James Harrington, *FAST—Fast Action Solution Technique*, Paton Press, Chico, CA, 2009.
7. H. James, Harrington, *Business Process Improvement*, McGraw Hill, New York, 1991.
8. H. James, Harrington, *Streamlined Process Improvement*, McGraw Hill, New York, 2012.

3

House of Lean Management

Faced with the choice of changing one's mind and proving that there is no need to do so, almost everybody gets busy on the proof.

John Kenneth Galbraith

IN A NUTSHELL

A Lean management system, along with the desired productivity and profitability improvements that are usually associated with it, can neither be achieved nor be sustained without having a well-defined structure. This structure is composed of three fundamental aspects:

1. Company-wide Lean philosophy
2. Organizational structure conducive to making it a reality through Lean learning and Lean practice
3. Complete house of Lean management (HOLM) infrastructure

On the basis of the manufacturing processes developed by Toyota, the concepts used in Lean thinking today can be represented using the aforementioned graphic, commonly referred to as the *house of Lean*. The house is a symbol used to show the coherence and harmony of the philosophy using the key components of Lean:

- *Just in time (JIT):* JIT (one of the two pillars of Lean) refers to supplying what is needed, when it is needed, and in the amount that is needed.
- *Jidoka:* Jidoka (the second of the two pillars of Lean) is a stop-and-respond approach—either machine or human—to halt production and address product defects or quality issues as they are encountered in a process.

- *Heijunka:* Referring to production *smoothing*, heijunka is the leveling of production volume and variety (waste) during given periods. Heijunka creates quality and stability; it is a prerequisite for JIT.
- *Standardized work:* Organizing a job or task in an efficient activity sequence while minimizing waste.
- *Kaizen:* A Japanese term that is translated to "change for the better." Kaizen is a philosophy of continuous improvement.

INTRODUCTION

As previously mentioned, the use of the term *Lean* in a business or manufacturing environment describes a philosophy that incorporates a collection of tools and techniques into the business processes to optimize time, human resources, assets, and productivity while improving the quality level of products and services to their customers. Becoming Lean is a commitment to a process and a tremendous learning experience should you attempt to implement Lean principles and practices into your organization. *Lean management* is a philosophy of rigorous continuous improvement that involves all employees, the goal of which is to constantly pursue the elimination of waste and reduction of variability, toward the pursuit of perfection in our processes and services. At its core, Lean management is all about

- *Understanding value, as defined by the customer:* What steps add to the customer's perception and understanding of what is truly valuable?
- *Identifying the value stream for products and services:* What flow of materials and information is currently required to bring a product or service to the customer?
- *Creating a flow of value from beginning to end:* Where are the opportunities for improvement (e.g., eliminating unnecessary steps and reducing waste) within the value stream?
- *Pull from the customer:* As flow is introduced, how will customers be able to pull value from the next upstream stage of the process?
- *A continuous pursuit of perfection:* As value is continuously identified, and waste and non-value-adding steps are eliminated, how can we continue to improve on our processes to ensure that customers will continue to receive what they need and expect—the perfect customer experience?

HOUSE OF LEAN MANAGEMENT

Although the term house of Lean has been around for many years, most often structured as a simple group of tools, HOLM is less than 10 years old.* Over the years, those wishing to apply Lean concepts have come to recognize what we in the Lean community have known for a long time: tools alone will not produce the lasting improvements desired by today's management. It has become obvious that the key factors restricting the adoption of a Lean philosophy are, for the most part, people related.

Three fundamental issues or problems are inherent in any production system, from manufacturing to service to government operations. They are

1. Waste (muda)
2. Instability (muri)
3. Variability (mura)

These basic problems reduce system efficiency by exerting a negative effect on quality, costs, and delivery times. The end result is a lower return on investment (ROI). Lean manufacturing, which is the root application of the house of Lean, is a variation on the theme of efficiency based on optimizing flow; it is a present-day instance of the recurring theme in human history toward increasing efficiency, decreasing waste, and using empirical methods to decide what matters, rather than uncritically accepting preexisting ideas. As such, it is just one component in the larger infrastructure that also includes such concepts as

- Folk wisdom of thrift
- Time and motion study
- Taylorism and the efficiency movement
- Fordism

* HOLM was introduced by Frank Voehl in 2003 during a conference presentation for the American Society for Quality. During the conference, the model was introduced and compared with the House of Total Quality, also created by Voehl in 1992 and first published in the St. Lucie Press *Total Quality (TQ) Series*. Like the HOLM model, the House of Total Quality model was a simple and highly visual structure consisting of six components. (See *Total Quality in Managing Human Resources*, by Petrick and Furr [1995], or Total Quality in Higher Education, by Lewis and Smith [1993]).

Lean manufacturing is often seen as a more refined version of earlier efficiency efforts, building on the work of earlier leaders such as Taylor or Ford and learning from their mistakes.

However, the modern view takes a more holistic approach where the definition of waste is far more generic. Irregular production with ups and downs in production levels would be considered as waste. The goal of Lean then becomes the creation and maintenance of a production system that runs repetitively, day after day, week after week, in a manner identical to the previous period.

The house of Lean (Figure 3.1) is the symbol used by many consultants and practitioners to explain the integration, structure, and overall harmony of the Lean system of thinking, fulfillment, and/or manufacturing. As can be inferred structural stability is the foundation of the house, and as we apply these concepts to a business or organization we refer to overall process stability, methods standardization, and an integrated master plan and strategy monitored over time. The foundation of the house, on which all the remaining structure is built, has two key elements: an attitude of continuous improvement, often called Kaizen, and elimination of the muda and muri, both of which set the system of Lean thinking in motion.

There are at least two pillars for the house of Lean structure, JIT and Jidoka, which are simply explained as follows:

- *Heijunka:* Smoothing and sequencing of production
- *Standard work:* Reduced variability of the pace and processes of work
- *Theory of constraints (ToC):* A system designed to eliminate bottlenecks and absorb sudden demand fluctuations as well as possible

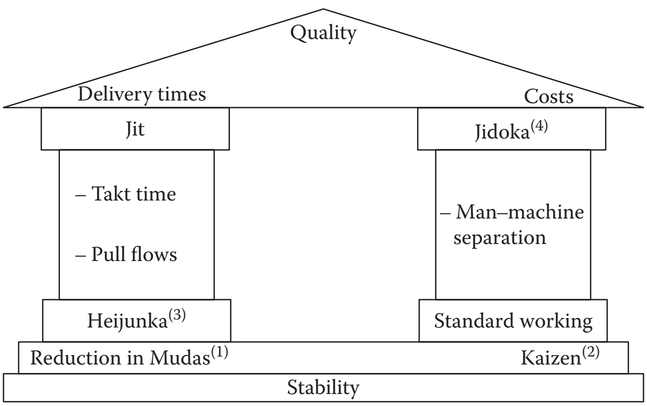

FIGURE 3.1
Traditional house of Lean.

Above the foundation of the Lean house are the pillars. In a typical organizational setting, these pillars represent JIT, Jidoka (quality), and motivated people, according to the Toyota Production System (TPS) where they are actually in a certain order. Typically, the middle pillar is described as the most important pillar and it is the one consisting of motivated people.

In short, the purpose of the pillar is that it is the actual conduit or vehicle that is used to apply the foundation blocks. Management decides on how they are going to use each of them to achieve the best results with their customers. For example, social media is often used to support and enable people to get to know the organization and its website to gain more acceptance. Companies can have free trial offers to build trust, low-cost seminars for trial, and so on. All of the foundation blocks are applied through these pillars only when a customer wants and needs them. The number of pillars represents the different sales/marketing channels that are created. Segmenting the customer database into as small a group as possible will always make marketing more effective. As an analogy, consider a toothpick placed on its side and the little strength that it has. Of course, it is very weak; but so will your marketing efforts be when you are trying to be all things to all people, to everybody. Literally, your sales will be flat and the cost of marketing will be astronomically high. However, if you stand the toothpick (pillar) up in the air, you can segment your customers using multiple channels and your marketing becomes more effective. If you can somehow magically make your actions flow upward, then your marketing gets leaner.

The tools used in the walls of the house to support its roof—the objective of the method—are as follows:

- *For the JIT pillar:* Pulled flow, takt time, and continuous flow
- *For the Jidokapillar:* Man–machine separation (one operator manages several machines) or autonomation (one operator manages several machines)

The roof, or objective of the house of Lean method, is summarized by reduced production costs, improved quality level, and matching delivery times to customer needs.

Transition to the House of Lean Management

The HOLM, with its six components, builds on the house of Lean by addressing the company culture, or people-related requirements, as fundamental to the success of the Lean thinking journey of the organization.

There are five components (subsystems) for the HOLM (Figure 3.2). The first component is the roof or superstructure, which consists of four organizational subsystems where the work actually gets done:

1. The socio-technical system
2. The quality management system
3. The educational system
4. Change management system

These four subsystems are *must haves*, which are required to develop an effective Lean management system, as they address the critical company culture development and the integration of people into your Lean management system. The change management component is the mortar

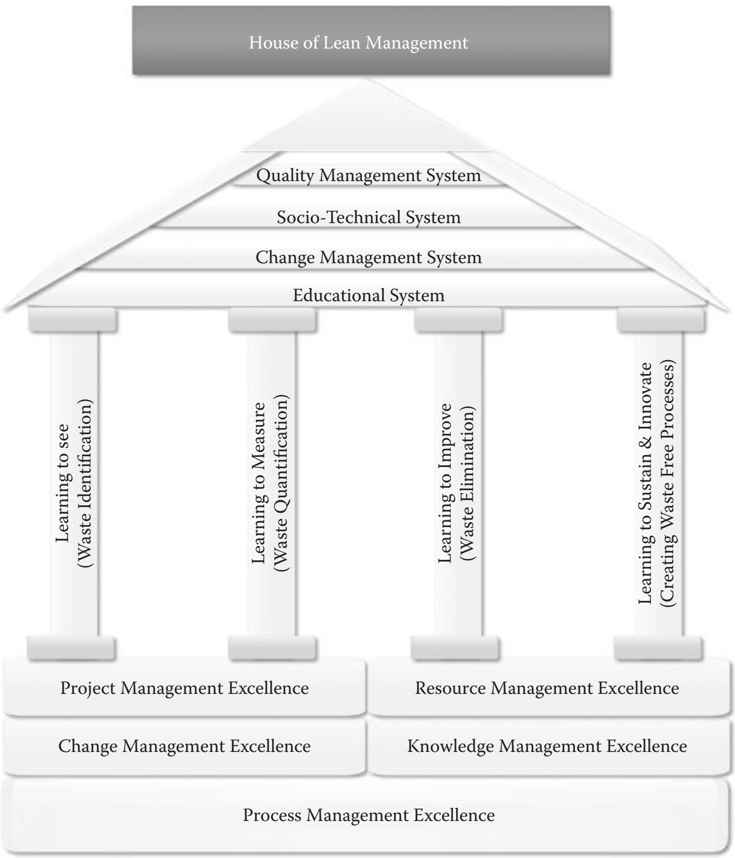

FIGURE 3.2
House of lean management.

of deployment; this binds the roof, pillars, foundations, and cornerstones together, and this mortar is sustainability. In a Lean management environment, sustainability can primarily be achieved through Kaizen, which is the driving improvement force of a Lean company culture. Sustainability, a current topic of much of the literature, can only be achieved through the effective deployment of Kaizen philosophy with the participation of every employee across the organization.

The HOLM is composed of several fundamental *rooms* or blocks, along with the four pillars. These are organized into logical groupings or rooms of the *Lean Management Handbook* and consist of (1) Fundamentals of the Lean Management System (Chapter 4), (2) Lean Socio-Technical System (Chapter 5), and (3) Lean Educational System (Chapter 6). The four pillars are (1) Waste Identification—Learning to See (Chapter 7); (2) Waste Quantification—Learning to Measure (Chapter 8); (3) Waste Elimination—Lean Concepts, Tools, and Methods (Chapter 9); and (4) Kaizen—Learning to Sustain and Innovate or Learning to Improve (Chapter 10).

Toward the end of the handbook, we introduce Lean as it relates to and can be used in conjunction with other prominent improvement philosophies. We discuss

- Lean Thinking (Chapter 12)
- Lean and the DMAIC/DMADV approach of Six Sigma (Chapter 13)
- Lean and the Theory of Constraints (Chapter 14)

We conclude this handbook with chapters covering the culture aspects of the Lean management system, including the role of the facilitative leader.

Lean Activity Model

Different activity models can be considered when constructing your own unique application of the HOLM. The most useful and common approach we have found is in the generic *Create a Lean System* deployment model, shown in Figure 3.3.

A true deployment for the Lean management system as shown in Figure 3.2 must be formulated, created, defined, and deployed with significant commitment from management and inputs from suppliers and the marketplace, where demand is calculated using Lean tools and techniques. The primary role of management in a Lean organization is to support *Gemba* (where all value is created). Because of the critical nature of management's role in transforming its organization to a Lean organization,

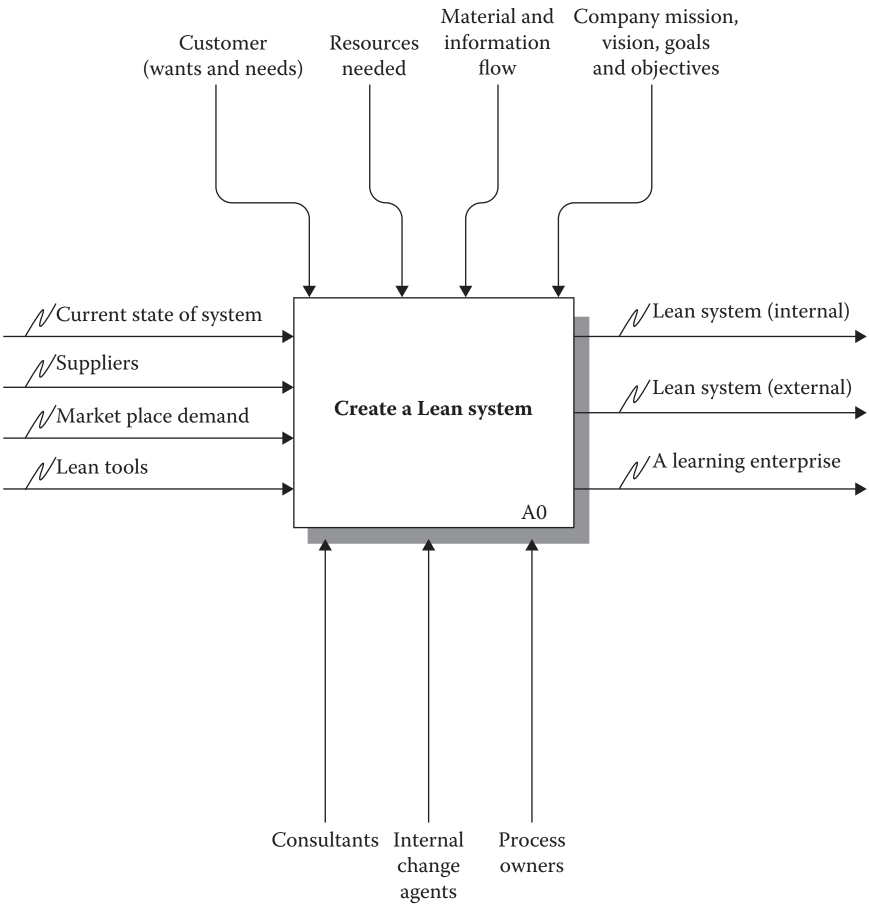

FIGURE 3.3
Create a Lean system.

it is presented as the foundation for creating a Lean management system for your organization. Gemba means *real place* or where the *action* is or, more importantly, as far as an organization is concerned, where value is added for the customer. The concept of Gemba is so entrenched in Japan that even today reporters in Japan still use the phrase "reporting live from Gemba." In business, Gemba is the most important place in your company. It is where all value is created for your customers. Gemba is a source of all important information necessary to respond to customer requirements. Everyone at every level of your organization must understand that their primary function in the company is to support and improve Gemba (Imai, Massaki 1997).

Consequently, managements' role, and we should go so far as to say its primary role, in creating a Lean management system is to provide support to Gemba. However, not all responsibility is laid at the doorstep of management. In a Gemba-centered approach, Gembais accountable not only for production but also for quality and cost, whereas organizational support staff assists from the sidelines. This is in stark contrast to Western companies where it appears to the trained Lean practitioner that Gemba is there to provide jobs for support staff and management. In the Lean organization, Gemba must accept accountability for achieving performance and it must also be allowed enough elbow room to effectively conduct process improvement (Imai, Massaki 1997).

Management should not only provide the target for Gemba to achieve but all those employees in Gemba should be accountable for the outcome while management should assist the workers in any way possible to achieve the target. Management's role is showed primarily as a supportive one for Gemba, which is located at the top of the organizational structure on the inverted pyramid. This both signifies the importance of Gemba to organizational success and serves as a reminder that management's primary role is to support Gemba. This is in stark contrast to traditional organizations where organizational charts and structures always feature management on top of the structure. The following framework for Lean Management Implementation is a generic model for Lean implementation,* which is in the public domain and is a useful metaframework that is covered in the remaining chapters in this handbook.

A Framework for Lean Management Implementation

Regarding Lean management system implementation, it has been argued that the two basic concepts in Lean thinking are to eliminate waste and create value. A further expanded view includes the research and writings of Womack and Jones (1996), which presents a more detailed framework with five basic steps of specify, perform, document, visualize, and foster.

The following is a brief description of these five steps. Throughout this handbook we integrate a range Lean concepts into the HOLM. Further

* "Lean manufacturing measurement: The relationship between Lean activities and Lean metrics", by Diego Fernando Manotas Duque and Leonardo Rivera Cadavid. This paper aims to integrate a set of metrics that have been proposed by different authors in such a way that they are consistent with the different stages and elements of Lean manufacturing implementations. To achieve this, two frameworks for Lean implementations are presented and then the main factors for success are used as the basis to propose metrics that measure the advance in these factors. Finally, some ideas for future research and extension of the applications proposed on this paper are presented as closing points.

expansion of these steps to include employee interactions and facilitation are expounded upon in Chapter 15.

1. *Step 1 is to specify value:* What do your clients and customers want? When and how do they want it? What types of combinations of features, capabilities, availability, and price will be preferred by them both today and a year or two from now?
2. *Step 2 is to perform a value stream analysis:* A value stream is defined as the collection of processes and activities required to bring a product to the customer, in its totality from beginning to end. The value stream is not limited by normal boundaries that exist between companies. Hence, this is the reason to strive to integrate suppliers, manufacturers, distributors, and even retailers in the efforts to recognize and analyze the value stream and lower the overall cost, improve quality, and speed up fulfillment. Also, three main categories of activities are distinguished: (1) activities and tasks that add value, (2) those that do not add value but cannot be currently avoided as they are needed by the organization to stay in business, and (3) those that do not add value to either the customer or the organization and should therefore be eliminated.
3. *Step 3 is to document continuous flow:* All types of organizations should try to make value flow continuously, not in batches. In this paradigm, the term *one-piece flow* has great appeal and is a highly desirable component of the Lean management system. Also, traditional functional organizations do not help but usually impede continuous flow; therefore, a focused-team cross-functional approach is closer to the product and is normally recommended.
4. *Step 4 is to visualize customer pull:* A principle originally made popular by JIT concepts that states that companies should not *push* their products to customers, but rather let customers pull value packages (products or services) and link all the production chain, including the suppliers, in such a way that materials are not released—and activities are not done—until they are needed. As previously mentioned, the discipline of pull is established and enforced by using *Kanbans*, which are physical or electronic mechanisms to transmit the need for parts and subassemblies from one point in the process to the preceding one.
5. *Step 5 is to foster continuous improvement:* One of the most successful and popular commercial slogans for the Toyota luxury brand Lexus put it as follows: "the passionate pursuit of perfection." It is

based on the premise that the Lean management system improvement efforts are never finished, and it provides the consistency to keep the discipline for improvement in place (Kaizen).

These implementation activities should lead to improvement in five dimensions, which are the concepts the company is trying to put into action:

- Elimination of waste
- Continuous improvement
- Continuous flow and pull-driven systems
- Multifunctional teams
- Information systems

The degree to which these goals are actually accomplished in a Lean management system will lead to the inclusion of metrics that reflect the advancement of a team or line in the implementation of Lean thinking, as shown in Figure 3.4.

It may take months or years for this philosophy to sink in and be accepted by management. Many organizations fail to implement a Lean management system simply because they are unwilling to adopt this fundamental Lean philosophy. It is impossible to build a house of Lean in your organization without accepting this belief. Once management is

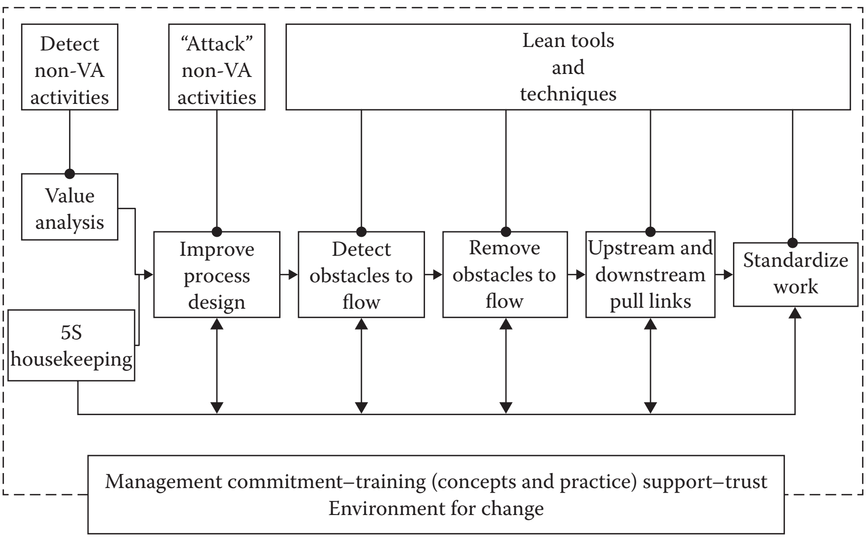

FIGURE 3.4
Categories for Potential Measurement in a Lean Management System.

comfortable with this philosophy and accepts it as critical to operating a Lean management system, a Gemba-centered approach can begin to flourish.

The attributes of developing a Lean management system focused on Gemba are critical. These can emerge only after the organization defines, develops, and deploys the concepts presented in Chapters 4 through 11. These daily actions embrace Kaizen process improvement and show that all employees are acting as teacher–mentor–supporter. As the overarching component of the roof, the Lean management system describes the comprehensive effort to develop, promote, and manage the spreading of a *Lean learning environment* across the organization. It requires change to occur through Lean leadership by Lean practitioners. It mandates the fostering of new belief systems for individual employees and the organization at large. It must be the documented structure within the organization for a Lean learning environment to develop and flourish.

Inclusion of Lean Management System Indicators and Metrics

For each of the five improvement dimensions, there are several indicators that can show the company the evolution of the line in its Lean Management System (LMS) evolution:

Elimination of waste: As previously outlined, waste is everything that does not add value to the product, like inventories, machine setups, machine downtime, movement of parts, and scrap. Therefore, the metrics should reflect those categories of waste:

- Work in process (WIP): value of WIP in the line.
- Setup time: time spent in setups/total productive time (percentage).
- Machine downtime: hours lost by the machine because of malfunction/total machine hours scheduled (percentage).
- Transportation: number of parts (trips) transported as in distance.
- Space utilization: how much area does the line need, including its WIP and tools?

Continuous improvement: It represents the discipline of considering evolution as the normal state of a system. Some ideas to measure this include the following:

- Number of suggestions per employee per year.
- Percentage of suggestions that get implemented.

- Scrap: percentage of the products that need to be scrapped.
- Rework: percentage of the units that need to be sent to rework.

Continuous flow and pull-driven systems: It is the ability to abandon the batch mentality and adjust the processes to accept smoother movement of products through the line, which are going to be triggered by the pull of the customer of each process. Some metrics are the following:
- Lot sizes: average lot size for each product.
- Order flow time: time an order spends being processed in the shop floor.
- Order lead time: average time from the placement of an order (by a customer) to its delivery.
- Pulling processes: percentage of the line processes that pull their inputs from their predecessors.
- Pull value: percentage of the total annual value or throughput of the system that is scheduled through pull mechanisms.

Multifunctional teams: In Lean management system implementations, teams have more responsibility and autonomy, so improvement and problem solving can happen closer to the source. Also, to make flexibility in the line feasible it is necessary to have a multiskilled workforce. Some metrics for these aspects are the following:
- Autonomous control: percentage of quality inspection carried out by the team.
- Work-team task content: percentage of the tasks required to make the product performed by the team.
- Cross training: average over team members of number of skills a team member possesses/number of skills needed in a team.
- Number of employees capable of assignment rotation.

Information systems: The reduction of vertical levels in the structure and the autonomous operation that teams have to reach makes necessary that employees have timely access to better information to enable problem solving and decision making. It does not necessarily mean, but it certainly does not exclude, computerized information systems. Some metrics include the following:
- Frequency with which information is given to employees.
- Percentage of procedures that are documented in the company.
- Frequency with which the line or cell progress boards are updated.

Conditions of Lean Enterprise	Supporting Activities
One-piece continuous flow	Value stream analysis, quick changeovers and single minute exchange of die, standardized work
Capable processes (few defects)	Six Sigma, total quality management; design for manufacturability; Design of Experiments (DoE); define, measure, analyze, improve, and control; define, measure, analyze, design, and verify; design for Six Sigma; error proofing (poka-yoke)
Reliable processes (high equipment uptime)	Total Productive Maintenance (TPM)
Pull scheduling	Kanban, production smoothing
Trained and engaged workforce	Team culture, training, policy deployment, goal sharing, profit sharing
Visual control	Andon boards—visible performance metrics, 5S

Conditions of a Lean Learning Enterprise

The six conditions of a Lean enterprise* and its supporting activities are (1) one-piece continuous flow, (2) capable processes with few or no defects, (3) reliable processes with high uptime, (4) pull versus push scheduling, (5) a trained and engaged workforce, and (6) visual control.

Lean Socio-Technical System

It has been long known that the social system or company culture plays a key role in the relative success or failure of improvement efforts. The Lean socio-technical system is the collective belief system or company culture on which decisions are made daily by employees at all levels. Individual and organizational beliefs influence relationships across the company. The beliefs and behaviors of management are transmitted to all employees and ultimately get reflected in employee behavior with management, between peers, and toward subordinates. The three primary people drivers are derived from the basic human needs defined by Abraham Mazlow. These are based on an individual's underlying beliefs, his or her perception of fear, or an organization's measurement system. Management directives typically tend toward one of the two dominant management philosophies: Theory X or Theory Y. Theory X

* *Source:* Moresteam.com. See their website for details.

is a top-down approach favored by managers in traditional organizations, whereas Theory Y is more of a people-centered approach in line with developing an empowered employee environment. A Lean management system can be achieved from either starting point; however, Theory Y management is fundamental for a Lean management system to exist and thrive. (Chapter 5 discusses the socio-technical system in detail.)

Lean Educational System

Regardless of the industry you are in, your product type, and the type of service you deliver (be it healthcare, heavy manufacturing, government agencies, or nonprofit organizations), there is a common thread among Lean organizations of all industries. They all profess and practice an open Lean learning environment where observation and experimentation with improvement is encouraged; supported; and, more importantly, rewarded. In these organizations, employees are constantly developing deeper knowledge of the processes that they use to create value for the customer and constantly refining their understanding of customer requirements and expectations. As a critical component of a Lean management system, the Lean education system must be prominent in the organization structured for all employees, executive groups, senior managers, department managers, supervisors, team leaders, line staff, and support staff. It must be visible to all employees across the company so that sharing of improvement activities is a natural daily activity. (Chapter 6 describes the components necessary to develop and deploy a comprehensive Lean education system.)

Lean Change Management

The ability of an organization to understand and manage change is critical to becoming a Lean organization. To change, we must know what we are changing from and what we are changing into. Many people are uncomfortable with change because with it comes a level of uncertainty about the future. How will this change affect me? Transitioning from the comfortable and nearly constant daily activities to an organization that embraces change and promotes an employee-learning environment is difficult for companies to achieve. One effective model developed by William Bridges breaks the change process into three distinct human activities.

This is one of the models for effective change management presented in Chapter 10. The three-step change process includes the following:

- Shedding old beliefs: this means that all employees develop their personal ability to let go of old beliefs. This can be a difficult challenge for many employees.
- Moving your frame of mind to a *neutral zone* where employees are receptive to new ideas, new ways of thinking and working, or new points of view. This is where the Lean learning environment exists and all employees begin to adopt a fundamental Lean belief system. This is where observation, experimentation, and transitions begin to be formulated, tested, and refined.
- Starting the *new beginning*: this is where individual employees and the organization at large begin to expose the new Lean identity and live Lean on a daily basis.

Four Pillars of the Lean Management Model

The four pillars of the Lean management system model teach us to observe our processes with a Lean eye. As we do, we will recognize the importance of living these behaviors on a daily basis and develop a deeper understanding of what it means to be a Lean organization, that is, to identify and eliminate these wastes across the organization:

- *Pillar 1: Waste identification—Learning to see*
  - The first step is learning to see waste. What is waste? What causes waste? How could we possibly see today what we could not see yesterday? This is the most important pillar; after all, we cannot change what we cannot see. (In Chapter 7, we describe this pillar in detail.)
- *Pillar 2: Waste quantification—Learning to measure*
  - Once we can see a waste and have identified what the waste is and where it is occurring, we should quantify it, if we can. Most wastes can be quantified. With others, it is sufficient to recognize and document the nature of the waste. The key in measurement is to begin to distinguish between Lean measures and non-Lean measures. Non-Lean measures are typically dead costs or non-flowing measures, such as raw materials' cost or labor cost. Lean measures are those that are first externally focused on customer requirements, are performance in nature, or contain qualitative

or quantitative aspects of one of the nine wastes. For example, in place of the traditional material or labor cost we could use a manufactured cost per piece that includes both materials and labor, along with productivity, overheads, and quality components. The objective in a Lean environment is to establish a process that produces 100% first pass quality. (In Chapter 8, we explore converting your organization from traditional measures to Lean measures.)

- *Pillar 3: Waste elimination—Lean concepts, tools, and methods*
  - Armed with the tools of observation and quantification, we are now positioned to address how to go about improving. At this point, employees are becoming Lean practitioners and will never look at or measure your processes as they did before being in the Lean learning environment. Your Lean management system is taking shape, and your employees are building your Lean organization, one that is fundamentally strong and will achieve higher levels of productivity and profitability than previously possible. There are a series of Lean tools that are focused on eliminating the observed nine wastes. These tools, when implemented properly, directly attack the waste and either minimize or eliminate it all together. Some of the tools are qualitative, whereas others are quantitative*; all collectively add up to high performance. Employees begin to focus on what the future state of company performance can be and actively begin setting targets. (In Chapter 9, employees learn Lean concepts, tools, and methods; how to use them individually and together; and where and when to use them.)
- *Pillar 4: Sustain and innovate (Kaizen)*
  - Many companies today are struggling with sustaining process improvements. This is not surprising because they are typically not willing to adopt the Lean philosophy, education system, or change management system necessary to sustain a Lean environment. A true Lean management system can only be sustained through systematic deployment of the Kaizen improvement philosophy across the company. The Kaizen equation is simple: change + improve = sustain.

* In the Lean Six Sigma Black Belt Handbook, Voehl, Harrington, Mignosa, and Charron (2014) present a wide variety of statistical and nonstatistical tools for waste elimination to supplement this text.

- Kaizen is the lifeblood of a Lean organization and a Lean management system. It can be used individually, in teams, or for process troubleshooting and is about taking positive action. When used in conjunction with the Lean socio-technical, Lean educational, and change management systems presented in this handbook, Kaizen becomes the perfect conduit to deploy education and beliefs and apply Lean tools across your organization.
- Kaizen is a daily activity, the purpose of which goes beyond simple productivity improvement. It is also a process that, when done correctly, humanizes the workplace, eliminates overly hard work (muri), and teaches people how to perform experiments on their work using the scientific method and how to learn to spot and eliminate waste in business processes.* (In Chapter 10, we present change through Kaizen.)

Summary of the House of Lean Management

The HOLM shows the requirements of a Lean organization. Establishing a systematic approach to understanding your social system, creating a Lean learning environment, and taking on change management issues as they arise in the Lean transformation are all necessary to achieve Lean performance. All employees must embrace and adopt a Lean philosophy, promote Lean behaviors, and live Kaizen on a daily basis. The demands for predictable machine performance in Lean manufacturing led to the development of TPM. Early on, the people at Toyota must have realized that many quality problems and setup problems originate from poor maintenance. Quality management techniques, statistical process control (SPC), and problem-solving teams transferred well to maintenance issues. Reliability-centered maintenance (RCM) also contributed. RCM developed from the military's development of reliability theory, which, in turn, came from statistical theory. Statistical theory also contributed to the development of SPC. The use of problem-solving teams came from Eric Trist's socio-technical systems as well as from Reg Revans' action learning.

* Taiichi Ohno and Shigeo Shingo developed both Kaizen *events* and Kaizen *blitzes* at Toyota. They are important tools for Lean manufacturing, TPS, JIT, and other effective manufacturing strategies. People at all levels of an organization can participate in Kaizen, from the chief executive officer down, as well as external stakeholders when applicable. The format for Kaizen can be an individual, a suggestion system, a small group, or a large group. In modern usage, a focused Kaizen that is designed to address a particular issue over the course of a week is referred to as a Kaizen blitz or Kaizen event. These are limited in scope, and issues that arise from them are typically used in later blitzes.

The following is a summary of some Lean management system results reported by industry*:

- MRC Bearings reduced unplanned downtime by 98% in one cell and 99% in another, all within 1 year.
- Monsanto runs their 3-year-old Lean management system in a start-up plant at 97% on-stream time, whereas most other units run between 85% and 90%, with each percentage point equivalent to about $1 million annually.
- Harley-Davidson estimates that the ROI from Lean management and TPM is 10-fold the cost of implementation.
- Kodak reported a $5 million investment in Lean management that resulted in a $16 million increase in profits.
- 3M reduced their maintenance cost by 60% within 3 years.
- DuPont reduced the Cost-of-Quality by 69% and improved capacity by 29% in 3 years.

FIVE FOUNDATION STONES OF THE LEAN MANAGEMENT SYSTEM†

> No person or company should be content to stay where they are, no matter how successful they now seem to be.
>
> **Stephen R. Covey**

Organizational excellence is designed to permanently change an organization by focusing on managing the five key foundation stones of the organization. Each of these foundations is not new by itself. The key

* *Source*: *Manufacturing Plant Layout: Fundamentals and Fine Points of Optimum Facility Design*, by StrategosInternational–affiliate Ed Phillips. This book is well researched and presents a step-by-step guide to planning new factories and plant rearrangements. This book has analytical methods for space, activity–pair relationships, materials handling, and alternative layouts. It weaves together layout, cells, JIT, demandflow, and ToC in addition to traditional job shop and line operations.

† These five foundation stones were originally published as *the Five Pillars of Organizational Excellence*. The *Five Pillars Series*, developed by Jim Harrington and Frank Voehl, laid out the basics of organizational excellence in terms of the five critical elements of the modern corporation: knowledge, process, projects, resources, and change management. They are being adapted here for the Lean management system and treated as the key underlying foundation of Lean management.

to organizational excellence is combining and managing the foundation stones together. We call the methodology that provides a holistic approach to improving the organization's performance organizational excellence, which is supported by the five foundation stones that must be managed simultaneously (see Figure 3.1). The five foundation stones are

1. Process management excellence
2. Project management excellence
3. Change management excellence
4. Knowledge management excellence
5. Resource management excellence

Managing these five foundation stones means that we need to do the following effectively and efficiently:

- We need to manage our processes and continuously improve them for they are the way we do business.
- We need to manage our projects for they are the way we obtain major improvements in our processes and, today, most organizations are doing a very poor job of project management as demonstrated by the high failure rate of projects.
- We need to manage the organization so that it is prepared for the chaos that it is being subjected to because of the magnitude and quantity of changes that must be implemented.
- We need to manage the organization's knowledge, which is the organization's most valuable asset. (It is the organization's knowledge that gives an organization its competitive advantage, as technology can easily be reverse engineered and transferred to any place in the world almost overnight.)
- We need to manage our resources and assets for they drive our business results.

By effectively managing these five foundation stones and the Lean management system while leveraging their interdependencies and reactions, an organization can bring about a marvelous transformation within itself. An organization will come out of its cocoon, which had been restricting its potential, and become a butterfly that will float on the winds of success and organization-wide self-fulfillment.

The five foundation stones of organizational excellence methodology was developed and adapted for organizations that hunger to achieve

maturity in their Lean management systems and obtain optimum results in the five *Ps* of Lean management:

1. *Pride:* Everyone is proud of the work they do and the organization they work for.
2. *Performance:* The entire organization operates at very high levels of Lean efficiency and effectiveness.
3. *Profit:* The organization is very profitable, so it can pay its employees a good salary and pay higher-than-average dividends to its investors.
4. *Prestige:* The organization is viewed as an admired place to work, and it is known for providing highly desired products and services.
5. *Pleasure:* Everyone enjoys coming to work and the jobs they are doing because they are doing something worthwhile and it is a friendly place to work.

Good is no longer good enough. Doing the right thing *right* is not good enough. Having the highest quality and being the most productive will not do it today. To survive in today's competitive environment, you need to excel at being Lean. To excel at being Lean, an organization needs to focus on all its parts, optimizing the use and effectiveness of all its resources. To excel, you need to provide "knock their socks off" products and services. You need to be so innovative and creative that your customers say, "I didn't know they could do that."

Foundation Stone I: Process Management Excellence

The process management concept is certainly not new to Lean management professionals; it is the basis of most improvement methodologies.

Definition: a process is a series of interconnected activities that takes input, adds value to it, and produces output. It is how organizations do their day-to-day routines. Your organization's processes define how it operates.

Two Approaches to Process Management

There are two basic approaches to managing processes. They are

1. The microlevel approach, which is directed at managing processes within a natural work team or an individual department
2. The macrolevel approach, which is directed at managing processes that flow across departments and/or functions within the organization

Most of the work that quality professionals do is related to continuously improving processes. Some of the tools we use include design of experiments, process capability studies, root cause analysis, document control, quality circles, suggestions, Six Sigma, Shewhart's cycles, ISO 9000, JIT manufacturing, and supplier qualification, among many others. Lean management in excellent organizations requires each natural work team (department) to continuously improve (refine) the processes they use.

Foundation Stone II: Project Management Excellence

According to the Chaos Report compiled by the Standish Group International,

- Only 26% of all projects are successful.
- Forty percent of all IT projects fail or are canceled.

Processes define how organizations function, and projects are the means by which organizations improve those processes.

Definition: A project is defined as a "temporary endeavor undertaken to create a unique product or service."

Projects in most organizations are mission-critical activities, and delivering quality products on time is nonnegotiable. Even in IT projects, things have changed. The benchmark organizations are completing 90% of their projects within 10% of their budget and schedule. Information systems organizations that establish standards for project management, including a project office, cut their major project cost overruns, delays, and cancellations by 50%.

The Project Management Body of Knowledge defines 69 different tools that a project manager needs to master. Few of the project managers that we have come in contact with over the past 50 years have mastered all of these tools. In today's complex world, most organizations have numerous projects going on at the same time. Many of these projects are interlinked and interdependent. Their requirements and schedules are continuously changing, causing a chain reaction through the organization. As a result, the organization cannot afford to manage each project one at a time. They have to manage their portfolio of projects in a Lean environment, making the proper trade-off of personnel and priorities.

Lean project management excellence focuses on how to use project management tools to effectively manage the organization's projects in a Lean manner, and to integrate them into the organization's total operations,

which means the effective integration of projects, resources, and knowledge to obtain business intelligence.

Foundation Stone III: Change Management Excellence

> Research confirms that as much as 60 percent of change initiatives and other projects fail as a direct result of a fundamental inability to manage their social implications.
>
> **Gartner Group**

We all like to think of ourselves as *change masters*; but in truth, we are *change bigots*. Everyone in the management team is all for change. They want to see others change, but when it comes to the managers changing, they are reluctant to move away from their past experiences that have proven to be so successful for accomplishing their own agendas. If the organization is going to change, top management has to be the first to change.

Change is inevitable, and we must embrace it if we are going to be successful in this challenging world. Change management excellence is made up of three distinct elements. They are

1. Defining what will be changed
2. Defining how to change in a Lean manner
3. Making the change happen within the context of the Lean management system

An effective change management system requires that the organization step back and define what will be changed. By this, we are not talking about reducing stock levels, increasing customer satisfaction, or training people; we are talking about the very fundamentals. Which of the Lean management system's key business drivers need to be leaned, changed, and standardized, and how do they need to be changed?

This means you need to develop very crisp vision statements that define how the Lean management's key business drivers will be changed over time. This requires that the organization have an excellent understanding of what its Lean business drivers are and how they are operating today. Then, the organization must define exactly how it wants to change these Lean business drivers over a set period.

Once the organization has defined what it wants to Lean, the organization can define how to Lean and change it. During this stage, the

organization looks at the more than 1000 different improvement tools that are available today, determines which tools will bring about the required changes to these key business drivers, and schedules the implementation of these tools and methodologies. Of the 1000 tools, about 100 directly or indirectly belong to the Lean classification. This schedule of Lean management tools and techniques makes up a key part of the organization's Lean management business plan.

The last phase in the change management process is making the change to Lean management happen. This is the area where behavioral scientists have developed a number of excellent approaches to break down resistance and build up resiliency throughout the organization, some of which are covered in Chapters 15 and 16 of this handbook.

Foundation Stone IV: Knowledge Management Excellence

> When a person dies, a library is lost.
>
> **H. James Harrington**

Today, more than ever before, knowledge is the key to organizational success. To fulfill this need, the Internet and other information technologies have provided all of us with more information than we can ever consume. Instead of having one or two sources of information, the Internet provides us with hundreds, if not thousands, of inputs, all of which need to be researched to ensure that you have not missed a key nugget of information. We are overwhelmed with so much information that we do not have time to absorb it.

With the almost endless amount of information that clouds up our computers, desks, and minds, a knowledge management system (KMS) needs to be designed around the organization's key capabilities and competencies.

What Is Knowledge?

Definition: Knowledge is defined as a mixture of experiences, practices, traditions, values, contextual information, expert insight, and a sound intuition that provides an environment and framework for evaluating and incorporating new experiences and information. There are two types of knowledge: explicit and tacit.

Definition: Explicit knowledge is defined as knowledge that is stored in semistructured content such as documents, e-mail, voicemail, or video

media. We like to call it hard or tangible knowledge. It is conveyed from one person to another in a systematic way.

Definition: Tacit knowledge is defined as knowledge that is formed around intangible factors embedded in an individual's experience. It is the personal, content-specific knowledge that resides in an individual. It is the knowledge that an individual gains from the experience or skills that he or she develops. It often takes the form of beliefs, values, principles, and morals. It guides the individual's actions. We like to call it soft knowledge.

Definition: Knowledge management is defined as a proactive, systematic process by which value is generated from intellectual or knowledge-based assets and disseminated to stakeholders.

Six phases are required to implement an effective KMS, which is integrated with the Lean management system deployment. These phases are

1. Phase I: Requirements definition
2. Phase II: Infrastructure evaluation
3. Phase III: KMS design and development
4. Phase IV: Pilot
5. Phase V: Deployment
6. Phase VI: Continuous improvement

One of the biggest challenges related to implementing a Lean KMS is transferring the knowledge held by individuals, including processes and behavioral knowledge, into a consistent format that can be easily shared within the organization in a Lean and rapid manner.

Foundation Stone V: Resource Management Excellence

Even the best ideas need resources to transform them into profit.

H. James Harrington

Nothing can be accomplished without resources. Resources are at the heart of everything we do—too little and we fail, too much and there is waste—to making our organization competitive. Too many organizations limit their thinking about resources to people and money. These two are important, but they are only a small part of the resources that an organization needs to manage.

Now, when we talk about resource management we are talking about it in its broadest sense. It is all the resources and assets that are available to the

organization. It includes stockholders, management, employees, money, suppliers, inventory, boards of directors, alliance partnerships, real estate, knowledge, customers, patents, investors, good will, and brick and mortar. It is easy to see when you consider all of the resources that are available to the organization that effective resource management is one of the most critical and complex activities within any organization. As managers and employees, we need to examine our own performance to be sure we are the best we can be.

Each of these resources needs to be managed in its own special way for an organization to become an excellent organization in a Lean management system environment. The big question is thus: how do you integrate and pull all these different activities and improvement approaches together and prioritize them? The Lean management system strategic vision helps to answer this question.

Documents Needed for the Lean Management System Strategic Vision

There are 11 kinds of documents that are needed in a Lean management system comprehensive strategic vision:

1. Mission statement
2. Value statements
3. Organization's vision statements
4. Strategic focus
5. Critical success factors
6. Objectives
7. Goals
8. Strategies
9. Tactics
10. Budgets
11. Performance plans

Resource management cannot be an afterthought; all executive decisions must be based on it. It requires a lot of planning, coordination, reporting, and continuous refining to do an excellent job at resource management. Too many organizations manage the operations by throwing more resources into the pot. They may be very successful with this approach as long as they have very little competition, but even the giants fail if they do not do an outstanding job of resource management. Just look at what happened to Big Blue.

Strategic Vision Sponsor's Role

How do strategic resource sponsors convey their value of a change to Lean management systems thinking? What is the role of the executive team in the following?

1. Vision statements
2. Town meetings
3. What if change does/does not occur analysis
4. Sense of urgency for Lean
5. Personal follow-up and Kaizens
6. Change in behavioral patterns toward waste and rework
7. Investment of resources in Lean thinking projects
8. Mitigation plans related to Lean risk management
9. Active participation in the Lean management system communication plan and implementation

SUMMARY

The use of the term Lean in a business or manufacturing environment describes a philosophy that incorporates a collection of tools and techniques into the business processes to optimize time, human resources, assets, and productivity while improving the quality level of products and services to their customers. As explained in this chapter, becoming Lean is a commitment to a process and a tremendous learning experience should you attempt to implement Lean principles and practices into your organization. Continuing on this thread, Lean management is a philosophy of rigorous continuous improvement that involves all employees, the goal of which is to constantly pursue the elimination of waste and reduction of variability, toward the pursuit of perfection in our processes and services. At its core, Lean management is all about understanding value, as defined by the customer. Next, identifying the value stream for products and services and creating a flow of value from beginning to end is crucial. Pull from the customer in a continuous pursuit of perfection is a key component of the Lean management system.

The house of Lean covered in this chapter is the symbol used by many consultants and practitioners to explain the integration, structure, and

overall harmony of the Lean system of thinking, fulfillment, and/or manufacturing. As can be inferred structural stability is the foundation of the house, and as we apply these concepts to a business or an organization we refer to overall process stability, methods standardization, and an integrated master plan and strategy monitored over time. The foundations of the house, on which all the remaining structure is built, has two key elements: an attitude of continuous improvement, often called Kaizen, and the elimination of the muda and muri, both of which set the system of Lean thinking in motion.

Overall, organizational excellence is designed to permanently change an organization by focusing on the principles of the Lean management system. Learning to manage them together is the key to success in the endless pursuit of improved performance. We believe that it is very important to understand that none of the five foundation stones can support organizational excellence alone, as all of them and the Lean management system must be equally strong to support the weight of excelling in the organization's interface with all of its stakeholders. The challenge that all excellent organizations face today is how to maintain an innovative learning culture and still maintain the procedures and structure needed to ensure optimum performance with the required high levels of customer and investor satisfaction.

USEFUL REFERENCES AND ASSOCIATED READINGS

1. G. Conner, *The Lean Activity Model Context: Lean Manufacturing for the Small Shop*, Society of Manufacturing Engineers, Dearborn, Michigan, Feld, W.M., 2001.
2. T.L. Jackson and K.R. Jones, *Lean Manufacturing: Tools, Techniques, and How to Use Them*, St. Lucie Press, Boca Raton, Florida, 1996.
3. J.K. Liker, *Implementing a Lean Management System*, Productivity Press, Portland Oregon, 1998.
4. M. Rother and J. Shook, *Becoming Lean: Inside Stories of U.S. Manufacturers,* Productivity Press, Portland, Oregon, 1998.
5. J.P. Womack and D.T. Jones, *Learning To See: Value Stream Mapping to Create Value and Eliminate Muda*, Version 1.2, June 1999, The Lean Enterprise Institute, Brookline, MA. Also see their website at www.lean.org for more information, 1996.
6. P. Ahlstrom and K. Christer, *Lean Thinking*, Simon & Schuster, New York, Periodicals, 1996.
7. J.H. Allen, "Change processes towards Lean production, The role of the management accounting system," *International Journal of Operations and Production Management*,16(11), 42–56, 2000.

8. L. Bamber and B.G. Dale, "Making Lean manufacturing work for you," *Manufacturing Engineering*,124(6), 54–64, 2000.
9. M.L. Bechtell, "Lean production: A study of application in a traditional manufacturing environment," *Production Planning and Control*, 11, 291–298, 1996.
10. A.M. Bonvik and S.B. Gershwin, "Navigating organizational waters with hoshin planning," *National Productivity Review*, 23–42, 1996.
11. D. Brunt, "Beyond Kanban: Creating and analyzing Lean shop floor control policies," Manufacturing and Service Operations Management Conference, 2000.
12. N. Chase, "From current state to future state: Mapping the steel to component supply chain," *International Journal of Logistics: Research and Applications*, 3(3), 259–271, 1999.
13. J.K. Cochran and S.-S. Kim, "Lose the waste: Get Lean!," *Quality*, 38(3), 34–39, 1998.
14. T.J. Conley, J.C. Kalyan, W.F. Frantz, and D.R. Myers, "Optimum junction point location and inventory levels in serial hybrid push/pull production systems," *International Journal of Production Research*, 36, 1141–1155, 1998.
15. J. Couretas, "Moving toward Lean manufacturing," *Aerospace Engineering*, 18, 21–24, 1997.
16. M.A. Cusumano, "Changed gang," *Automotive News*, 5725, 81–83, 1994.
17. J. Darlington, "The limits of Lean," *Sloan Management Review*, 3, 27–32, 1999.
18. J.C. Day, "Lean thinking and mass customization: The relationship between production and costs," *Management Accounting*, 77(10), 18–21, 1995.
19. R. Getty, "Integrating ergonomics into your Lean manufacturing agenda," *IIE Annual Solutions Conference Proceedings*, Cleveland, Ohio, 1999.
20. A.M. Ghalayani, J.S. Noble, and T.J. Crowe, "Ergonomics and the customer satisfaction model: Ergonomics in the language of business," *43rd Annual Human Factors and Ergonomics Society Annual Meeting Proceedings*, Houston, Texas, 1997.
21. W.M. Hancock and J. Matthew, "An integrated dynamic performance measurement system for improving manufacturing competitiveness," *International Journal of Production Economics*, 48(3), 207–225, 1998.
22. K. Hein, "Lean production: Implementation problems," *IIE Solutions*, 30(6), 38–42, 1999.
23. P. Hines, N. Rich, and M. Hittmeyer, "Creating continuous improvement synergy with Lean and ToC," *ASQ's 53rd Annual Quality Congress Proceedings*, 543–549, 1998.
24. P. Hines and N. Rich, "Competing against ignorance: Advantage through knowledge," *International Journal of Physical Distribution & Logistics Management*, 28(1), 18–43, 1997.
25. W.J. Hoop, and M.L.Roof, "The seven value stream mapping tools," *International Journal of Operations & Production Management*, 17(1), 46–64, 1998.
26. R. Hooper and C. Jones, "Setting WIP levels with statistical throughput control (STC) in CONWIP production lines," *International Journal of Production Research*, 36, 867–882, 1998.
27. B. Knill, "Lean operations—The route to competitiveness," *British Telecommunications Engineering*, 17(1), 2–9, 1998.
28. Z. Lin and C. Hui, "How Lean manufacturing matches today's business," *Material Handling Engineering*, 54(11), 87–91, 1999.
29. B.H. Maskell, "Should Lean replace mass organization systems? A comparative examination from a management coordination perspective," *Journal of International Business Studies*, 30(1), 45–60, 2000.

30. B.J. Schroer, M. Adams, S. Stewart, and P.J. Componation, "Lean accounting for Lean manufacturers," *Manufacturing Engineering*, 125(6), 46–54. Also see the website www.maskell.com for more information, 1998.
31. A.D. Toni, and S. Tonchia, "Continuous process improvement the quick step way," *Quality Progress*, 85–89,1996.
32. L. Tonkin, "Lean organization, management by process and performance measurement," *International Journal of Operations and Production Management*, 16(2), 221–236, 1997.
33. J. Petrick and D. Furr, *Total Quality in Managing Human Resources*, St. Lucie Press, Delray Beach, Florida, 1995.
34. R. Lewis and D. Smith, *Total Quality in Higher Education*, St. Lucie Press, Delray Beach, Florida, 1993.
35. F. Voehl, H.J. Harrington, C. Mignosa, and R. Charron, *The Lean Six Sigma Black Belt Handbook*, CRC Press, Boca Raton, Florida, 2014

4

Lean Management Systems

> You have to manage a system. The system doesn't manage itself.
>
> **W. Edwards Deming**

> When a good person meets a bad system, the bad system always wins.
>
> **Frank Voehl**

IN A NUTSHELL

The purpose of a Lean management system is to deploy and sustain a Lean production or fulfillment system because without a Lean management system.[1] Lean implementation often falters, sometimes fails, and virtually never lives up to its long-run promises. The one universal element in a successful Lean management system is leadership. Leaders are the driving force that can motivate employees at all levels to achieve and sustain a Lean management system. This applies no matter what the actual position is called, whether a leader who is responsible for a team or department, a value stream or plant, or a business unit or the organization as a whole. Expectations for processes and the ability to compare actual versus expected are the threads that connect the elements in a Lean management system culture. The person at the top of the unit, however defined, is in the position to set expectations and, more importantly, to follow up on them. The higher in the organization Lean leadership extends, the better the chances for success.

OVERVIEW

No one exemplifies the rise and failure of a Lean management system better than Toyota. Early in this chapter, we consider some recent challenges at Toyota that we believe unequivocally demonstrate this assertion. Recently, around the time of the recession, the famous auto giant was in chaos and some were calling for its imminent collapse. The world famous Toyota Production System (TPS) was under true fire: gas prices were high and getting higher; the recession was taking full hold of the American economy; Toyota's inventory of gas-guzzling small utility vehicles was increasing (even as demand was decreasing); and a media scandal regarding mismanagement, product quality, and massive recalls was threatening to be the downfall of Toyota. When all the dust settles and the final analysis is made, who knows exactly how history will describe these days. I cannot help but wonder if this time could be remembered as one of the finest hours in Toyota's history. The strength of their Lean management system came to the rescue and saved their company when most other companies facing the similar challenges would have folded. Time will tell.

First, we present an overview of Toyota over the past few years. We discuss some of their challenges and shortfalls; but, more importantly, their response to adversity was a testament that even the best companies at Lean management can lose their way from time to time and bounce back from the negative effects of weak management. My father once said to me: "Life has a way of knocking down even the best of us from time to time; it's what we do after we are knocked down that ultimately defines our character." Toyota's response during this challenging time speaks volumes and demonstrates its commitment to the Lean management system for which it is famous.

The main focus of this chapter is on a basic and fundamental high-level Lean management system model based on the indivisible concepts of education, application, and communication of all things Lean. We present these as emanating from a prism, much the same way that light is dispersed into its component parts of the spectrum. Your defined Lean management system is at the center of the prism. We discuss a few common complementary management/assessment models in this chapter as foundations on which to build your company-specific Lean management system. The house of Lean management, along with all subsequent chapters in this handbook, contains components to consider integrating into your Lean management system.

Lean management encompasses the entire organization and considers the expenditure of resources for any goal other than the creation of value for the customer to be wasteful and thus a target for elimination. Lean production focuses on waste elimination while improving flow from the process perspective through the customer lens. Working from the perspective of the customer who consumes (buys) a product or service, *value* is defined as any action or process that a customer would be willing to pay for, either directly or indirectly. The objective of Lean management systems is to accurately define and refine customer requirements and continuously eliminate waste from the process until your product or service is perfect from the customer's standpoint. Basically, a pure Lean environment is centered on creating value with a minimum of resource expenditures—doing more with less.

Lean manufacturing is a generic process management philosophy derived mostly from the TPS, and it was identified as Lean only in the 1990s. It is renowned for its focus on reduction of the original seven wastes to improve overall customer value, but there are varying perspectives on how this is best achieved. The steady growth and sharp decline of Toyota, from a small company to the world's largest automaker to the *fallen hero*, has focused attention on how they achieved and suddenly lost their edge. Making learning Lean, doing Lean, and communicating Lean easier to see and execute is the objective that underlies an effective Lean management system.

At this point, it is important to point out that Lean is about creating a perfect process where zero spoken accountability is required. Spoken accountability is required in companies that have poor processes. Whenever you find yourself having to speak about the word accountability, the process is broken; that means the process is poorly understood, poorly defined, not standardized and requires employees to interpret the surroundings to decide what to do—all signs of a weak process. Our Lean management system is about creating strong, robust processes where spoken accountability is irrelevant. Speaking of accountability, let us examine how Toyota faced some recent adversity and accepted full responsibility for its actions.

Toyota Challenge

Not that long ago, like many a Lean practitioner, our undivided attention was focused on the testimony of Akio Toyoda before U.S. Congress. At some point during the proceedings, I had an epiphany. I was watching a

historic event. It was not because it was the leader of a foreign corporation appearing before American Congress (which was the reason why many a media reporter was saying this was historic). My belief was, and is, that no American chief executive officer (CEO) would ever do this for a myriad of reasons: liability, ego, media backlash, stock price devaluation … the list of reasons popping into my head seemed endless. Even if an American company's CEO had been forced to appear in front of Congress, there would be no admissions of poor management, no statements of fault, and no recognition of the need to alter the company's behavior. The only statements would be those crafted by an army of legal specialists to do what? Keep the CEO out of jail and, of course, protect the company's revenue stream. It was then the true nature of what I was watching hit me. This event was historic to me because I was witnessing something rare—firsthand—from Toyoda himself. I was witnessing real Lean leadership in action.

This event is so rare and priceless as a learning instrument that I encourage everyone to save this video. Examine it from many aspects. There are a number of non-Lean management examples that led Toyota astray and a number of key Lean management initiatives that Toyota used to course correct. As I listened to him speak and the more I thought about what he was saying, the more I was proud to be teaching this philosophy and to be part of a profession that would show this type of real leadership.

Let us visit a few things that Akio Toyoda portrayed during this historic event. During this session, Toyoda covered a number of topics and answered a number of questions. Two very revealing quotes are as follows: (1) "We pursued growth over the speed at which we were able to develop our people and our organization" and (2) "I regret that this has resulted in the safety issues described in the recalls we face today, and I am deeply sorry for any accidents that Toyota drivers have experienced." First, these indicate Toyota's awareness and acknowledgment that rapid growth required hiring *outsiders*: employees who were not homegrown on Toyota's principles of philosophy, people, process, and problem solving. Second, after this critical realization Akio Toyoda accepted full responsibility and apologized. Both of these statements reflect Toyota's philosophy.

Some other common characteristics of true Lean management revealed in his testimony are as follows:

1. His total and unequivocal acceptance of responsibility.
2. His admissions of deficiencies and the need for improvements. At the time, some of these deficiencies were not even completely

understood by Toyota. This took remarkable courage and complete belief in the company's ability to understand and resolve the problems. Can you imagine the CEO of an American company making such statements? These are basically unthinkable statements for American management. First, they would not speak until they could say what the problem was and what solution they had already put in place to eliminate the problem. It is not so in a pure Lean management philosophy. We expose our weaknesses so that we can learn from them and improve, which was a point that appeared to be lost on the general media. Why was this not reported as a true strength of Toyota?

3. His determination to search for the true root causes of these deficiencies.
4. His humility in dealing with some of the misconceptions bandied about and presented in an almost hysterical fashion by the media.
5. His commitment that the company would change and make right what had gone wrong.

After witnessing one corporate scandal after another, and American CEOs over the past 15 years do nothing but evade responsibility for their actions, it was refreshing to see that at least one CEO would stand and face the fire. It was at this moment, even as some distinguished American publications were describing the downfall of Toyota, that it became evident to me that they would emerge from this adversity faster than many believed.

Fast forward a few years. Here we sit in 2014. What can we say about Toyota's management response and overall organizational response? They took decisive corrective actions. Wastes were identified, root cause analyses were conducted, and true corrective solutions were put in place. This is in stark contrast to the companies that use improvement tools for documentation purposes only. This entire episode with Toyota teaches the Lean community a singularly critical Lean lesson on the path to establishing a Lean management system, that is, management must be ready, willing, and able to identify waste where it occurs; acknowledge organizational weakness (for all employees to see, as Toyoda did); and embrace real Lean management improvement activities based on operational philosophy, people, process improvement, and problem solving.

What does a quick view of the data tell us about this challenging period for Toyota? Approximately 9.0 million cars were recalled

worldwide, 7.5 million in the United States alone.[*] Financial losses are estimated at $5.5 billion operations, $3 billion lawsuits,[†] although the true numbers will not be known for several years and could be more or less than what was estimated. One gage of organizational health as seen by the financial world is stock valuation. Toyota stock (TM) hit a stock price low of approximately $62 in November 2011 and was approximately $131 in July 2013. This valuation was near its 10-year high of $135 in December 2006.[‡] From a stock price standpoint, Toyota has returned as a world leader. This, more than anything, demonstrates why Toyota's Lean management system and operational philosophy is truly the gold standard.

Views on Toyota's Management

Over the years, we have observed the rise and (quick) fall of Toyota, which only rose again from its ashes. *The Economist* had an interesting article about the recent issues at Toyota, saying that unless they can find a solution to their problems their stint as the world biggest carmaker may be short (Losing Its Shine, December 2010). The article makes several interesting points on the basic fundamental reason for the decline. First, the competition is catching up to the company real fast:

> For years Toyota has been the quality benchmark for every carmaker, but at the very moment it faltered, others were finally catching up. The truth is that although a few fail to make the grade—Chrysler still has a lot of catching-up to do—most cars these days are extraordinarily well-made. The quality surveys by which buyers used to set such store are now based on minute differences. This is the main reason why the manufacturers' positions in the league tables have become increasingly volatile.[§]

This is related to an article Marty was discussing several months ago ("Southwest Flies to Logan and a Teaching Cliché Die") on Southwest's decision to fly from Logan: all airlines became discount airlines, and the field caught up with Southwest. Using the same methods that brought Toyota to the top, most carmakers can manufacture well-made cars. The second reason for the temporary decline of Toyota is not unrelated and

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* Huffingtonpost.com.
† Ibid.
‡ Investing.money.msn.com—Toyota (TM) 10-year stock tracking chart.
§ *The Economist*, "Losing Its Shine," December 2010.

is the recent surge in quality issues plaguing the firm. The reason is not unexpected: "People within the company believe these quality problems were caused by the strain put on the fabled Toyota Production System by the headlong pursuit of growth."*

When we teach about Lean operations and use Toyota as the poster boy (and the bedrock) of the method, we say that gradual and continuous improvements are the essence of the method. The key question we leave open is how to balance gradual improvement with quick growth that may hamper the ability to sustain the key drivers of the firm's success. Mr. Toyoda has taken the first step always suggested in the TPS: he pulled the legendary Andon cord.

> The test will be to keep the ingredients that have made Toyota great—the dependability and affordability—while adding the spice and the flavours that customers now demand. It will not be easy, and the competition has never looked more formidable. But by recognising the scale of Toyota's problems, by proclaiming their urgency, and then by drawing on the firm's strengths to fix them, Mr. Toyoda has already taken the first, vitally important, step towards salvation.†

There is good evidence that Toyota's management ignored their own production system and adopted a western management style that was internally focused, ignored quality issues, and put pressure on the supply chain for ever-increasing cost reductions regardless of raw material quality. In short, they (1) stopped listening to the customer; (2) stopped conducting morning markets to address quality issues as they arose; (3) punished the upward flow of information regarding poor quality products; and (4) lied to customers about design, performance test data, and product safety. All of these are more in line with a traditional organization and not a Lean organization. Basically, Toyota morphed into a management philosophy similar to other American auto corporations, by growing too fast and hiring management from outside Toyota rather than building from within; consequently, they began getting similar poor results.

There can be no stronger Lean learning example than this. Lean management means having the ability to reflect on your management decisions and conduct *continuous improvement*. These times for Toyota demonstrate that even the best Lean practitioners will lose their way if they fail to follow Lean principles, beliefs, and behaviors.

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* *The Economist*, "Losing Its Shine," December 2010.

† Ibid.

LEAN MANAGEMENT SYSTEM

Why do we need a Lean management system? An effective Lean management system model is one that allows for the education, application, and communication of Lean activities at all levels of an organization. It should simultaneously be both a conduit and a scorecard for your organizational measurement system. Think of it as a guide that connects the "why am I doing this" of employee activities to greater organizational objectives while being a common reference guide for all employees to simultaneously interact with. To an outside observer, it reflects the collective Lean awareness of all members of the organization. So, how do we approach constructing a Lean management system?

In Chapter 3, we presented and discussed the house of Lean management. The house of Lean management is what your organization will look like when you have a fully functioning Lean management system in place. For this house to become a reality in your organization, we must have a Lean management system model that will allow the components of this house to emerge.

The foundation stones are the result of effective education. They include process management excellence, project management excellence, resource management excellence, knowledge management excellence, and change management excellence. The pillars of the house of Lean management are the application of this education. Finally, the roof of the house of Lean management in essence is the communication of this education.

Because many organizations do not have a clear vision of this house of Lean management in advance, what they ultimately end up with is an organization that is riddled with process, project, and related deficiencies. In this chapter, we present and discuss the following three fundamental components of the Lean management system: (1) education, (2) application, and (3) communication. These aspects are primary elements of your Lean management system model, which will guide you to becoming a fully functioning Lean organization (Figure 4.1).

Education

The first step to a Lean management system model is putting together an effective education approach. Fundamentally, to become a Lean organization you must be a *learning organization* where employees at all levels of

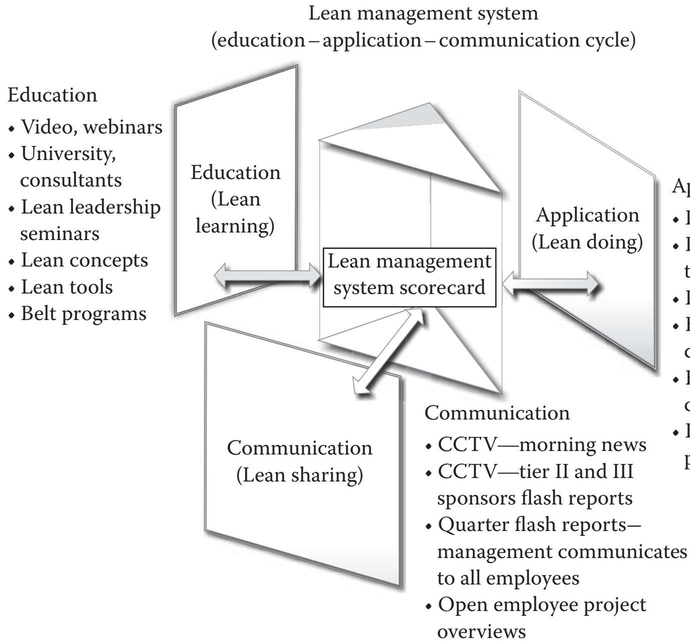


FIGURE 4.1
The Lean Management System Education and Communication Cycle. This figure depicts the four essential components and the 18 characteristics of the LMS communications cycle.

the organization are striving to learn and continue to refine what it means to be Lean. The education must focus on philosophy and concepts first, and tools and techniques second. The best programs tie the education (Lean learning) with the application (Lean doing) activities.

The overarching fundamental requirement for the Lean education approach is that it should include everyone in your organization from shop floor to C-level executive suite. Education can include off-the-shelf video learning libraries (e.g., Gemba Academy), online university course curricula, or instructor-led classroom activities. In addition, there are a wide range of educational opportunities in the forms of books, CDs, DVDs, webinars, interactive learning programs, and so on that can supplement your organization's approach to employee education at all levels. The range of these opportunities are focused at all levels of the organization from direct shop-floor participation through supervisory and mid-level management activities and ultimately to executive management.

Application

Lean has often been described as a participation sport. Lean management is no exception. The Lean practitioner is continuously looking to apply any new education via focused process improvement activities. Lean management (as a practitioner) has the task of self-development while creating an environment for employee development.

These application activities can take a wide range of approaches having common but different names. Examples are Kaizen and you, Kaizen in process troubleshooting, and Kaizen teams. Kaizen and you refers to any individual in the organization completing improvement activities in his or her sphere of influence. Kaizen in process troubleshooting refers to activities conducted by teams regarding root-cause analysis. Finally, Kaizen teams are the most common method of applying Lean concepts and tools to achieve enhancements. Chapter 10 furnishes a detailed look at applying Kaizen in your organization.

Other application programs can take the shape of long-term projects that are focused on reducing specific areas of the organization, increasing performance measures, or applying specific tools on a large scale across functional areas. Some examples of these would include inventory reduction programs, defect reduction programs, and space utilization.

Communication

Finally, as we proceed through education and application of Lean concepts, you need to effectively communicate the results of these activities to subordinates, peers, and managers. A comprehensive communication plan will encompass the entire value stream. A wide range of communication activities can be completed in the organization to achieve this goal. Some examples of these communication activities would include the following: newsletters, closed-captioned TV presentations, morning news, quarterly reports for management reviews, town halls, and employee project review presentations. During any Lean transformation initiative, every opportunity should be looked at to communicate the positive aspects of your Kaizen activities. An effective communication plan allows for a more rapid spread of Lean concepts and tools among employees. It promotes the cross-pollination of best practices and more effective communication between employees, departments, and functional areas.

DEFINING YOUR LEAN MANAGEMENT SYSTEM

An effective Lean management system includes all organizational activities and encompasses the following three critical systems: (1) technical system, (2) social system, and (3) educational system. Most prescriptions for implementing Lean are missing one critical ingredient: a Lean management system to tie together company-wide Lean activities that sustain the journey, a system that works to define the link between an organization's culture and its system including performance measures and management and management beliefs, daily habits, and routines. It provides a framework to see the differences between Lean and traditional cultures and details the practices, tools, and thinking for establishing Lean management. Our approach brings leadership focus and critical thinking to the table, and how to sustain and extend gains from implementing Lean projects, while providing the linkage of correctly managing Lean as a system and growing a culture of Lean thinkers.

Lean Management System Scorecard

At the heart of any Lean management system is an effective scorecard. Your scorecard is used as a guide or reference to gauge the relative effectiveness of improvement activities. There are many such Lean management system scorecards available that typically take the form of an assessment completed on a quarterly, a semiannual, or an annual basis. The assessments guide you on your continuing path to a sustainable and continuously improving Lean management system.

In this handbook, we present three management approaches to base your scorecard on. These include the Senge model, which is a *learning* management model; Jackson model, which is a *strategy* management model; and Shingo model, which is an *operations* model. Each of these approaches contains the requisite education, application, and communication components required to directly connect your overall management philosophy to employee participation and improvement projects.

The following sections are summaries of the prospective components of your Lean management scorecard. Chapters 5 through 19 in this handbook explore more detailed descriptions of the functional components that you can build into your Lean management system (Figure 4.2).

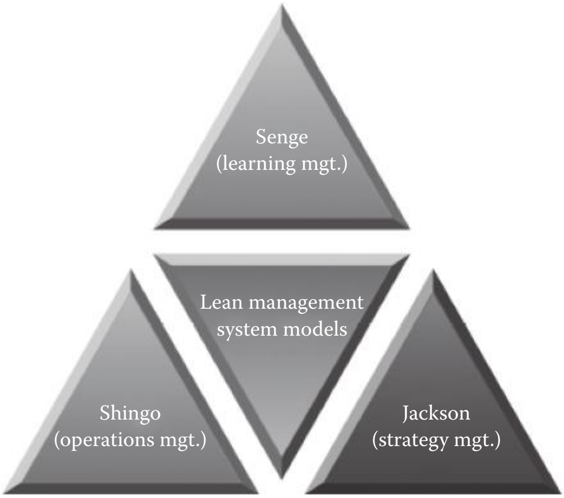


FIGURE 4.2
Management Approaches for Lean Scorecards. This figure depicts the integration of the Senge, Shingo, and Jackson Learning Management System (LMS) Models.

Learning Management Model (Senge)

As a result, the senior leadership team should be able to connect culture and the management system while avoiding a mass production culture and embracing a Lean culture. Peter M. Senge is an influential systems thinker from the Massachusetts Institute of Technology. He is the author of the book *The Fifth Discipline: The Art & Practice of the Learning Organization*; it was published in 1990, and a revised edition was published by Broadway Business in 2006.*

In Chapter 4, The Laws of the Fifth Discipline, Senge suggests some systems laws that help us understand systems better, which are as follows:

1. *Today's problems come from yesterday's solutions.*
   We humans are happy when we solve problems. We often do not think much about consequences. Surprisingly, our solutions could, and often do, strike back and create new problems.
2. *The harder you push, the harder the system pushes back.*
   We have this stubborn reaction to push our way through when things are not working out as we want. We charge without taking

* From Peter M. Senge. *The Fifth Discipline*, Century Business, 1992, pp. 424. ISBN 0-7126-5687-1. The five disciplines are (1) systems thinking, (2) personal mastery, (3) mental models, (4) building shared vision, and (5) team learning.

the time to stop, think, and find better alternatives. Sometimes we solve problems, but often we find ourselves up to ears in the swamp of other problems.

3. *Behavior grows better before it grows worse.*
   Short-term solutions give us a short break and temporary improvement but do not eliminate fundamental problems. These problems will make the situation worse in the long run.
4. *The easy way out usually leads back in.*
   We learn a few solutions that bring easy success. We try to vigorously apply them in any situation disregarding particular context and people.
5. *The cure can be worse than the disease.*
   Sometimes the easy or familiar solution is not only ineffective but also addictive and dangerous. It may even induce dependency.
6. *Faster is slower.*
   When we get a taste of success, we start to advance at full speed without much caution. However, the optimal rate of growth is usually much slower than the fastest growth possible.
7. *Cause and effect are not closely related in time and space.*
   We are good at finding causes to our problems, even if they are just symptoms and far from being real root causes.
8. *Small changes can produce big results, but the areas of highest leverage are often the least obvious.*
   Most obvious grand solutions such as changing company policy, vision, or tagline often do not work. Small, ordinary but consistent changes could make a huge difference.
9. *You can have your cake and eat it too—but not at once, without guilt or blame.*
   We often face rigid *either-or* choices. Sometimes, they are not dilemmas if we change our perspective and rules of the system. Because we like to blame and point fingers at other people or circumstance, we sometimes even believe our false assumptions are true. But we and the cause of our problems remain part of the system.
10. *Dividing an elephant in half does not produce two small elephants.*
    The inability to see the system as a whole can often lead to suboptimal decisions.

Lean management is a thinking system in which much the same rules apply. Senge's laws serve as an excellent aid to avoid Lean implementation

pitfalls. As we implement Lean solutions, we need to learn and understand the processes involved. There are many challenges to this way of thinking. Many such challenges can be defeated by gaining and using knowledge of how systems work. But the most serious challenge is our own contradictory human nature. Our passions, emotions, and instincts could easily defy this rational and systematic way of thinking.

All the aforementioned 10 observational laws or symptoms are the results of either a poor process focus or poorly defined social and educational systems. We address the development of Lean Social System and Educational Systems in Chapters 5 and 6, respectively, as a means to eliminating these 10 fundamental human observations.

Strategy Management Model (Jackson)

Nine Keys to Lean Management System

In his work *Corporate Diagnosis*, Productivity Press, Portland Oregon, 1996.[2] Jackson outlines and defines nine keys to a Lean management system.* According to Jackson, there are nine keys to a Lean management system, which form the main categories in which an organization charts its progress. (There are a number of references in the literature with variations on many of these keys.) A drive to build or improve the nine keys distinguishes a Lean manufacturer from a mass producer or a Lean service provider from a conventional service provider. Each key is associated with and helps regulate one of the growth cornerstones: strategy, structure, and strength. Each key is also specifically associated with a particular zero waste goal. View the zero waste chart in Table 4.1 for more information.

Each key has a set of related control points described as either Lean tools or business activities. Progress tables for each key give generic diagnostic questions that will enable you to audit your company on that key at a macro level and rate that unit on a scale of 1 through 5:

- Level 1: Plan mass production
- Level 2: Pilot system initiation
- Level 3: Deploy system development
- Level 4: Integrate system maturity
- Level 5: Excel system excellence

* Jackson's book *Corporate Diagnosis*, Productivity Press, Portland, Oregon, 1996.

TABLE 4.1

Zero Waste Relationship to Profit

Key	Zero Waste Goal	Relationship to Profit
1. Customer focus	Zero customer dissatisfaction	Customer input and feedback promote quality. Customer satisfaction supports sales
2. Leadership and strategic planning	Zero misalignment	Targets policy ownership and speed in achieving ROI
3. Organization architecture	Zero bureaucracy	Team-based operations reduce overhead by eliminating bureaucracy, while ensuring cooperation, information flow, and product or service flow
4. Lean supply chain	Zero stakeholder dissatisfaction	Flexible positive relationships and partnerships with suppliers, distributors, and society improve product or service quality, cost, and speed of delivery
5. Information architecture	Zero late information	Information required for decision making in operations is accurate and timely, thus improving quality, cost, and speed
6. Improvement technology	Zero waste	Employee participation in eliminating operational waste improves cost, quality, and speed
7. Production management	Zero nonvalue-adding work	Total employee involvement and aggressive waste elimination promote speedier operations, defect reduction, and lower inventories
8. Equipment/process management	Zero failures, zero defects	Improved equipment design and longer equipment life reduce costs. Meticulous maintenance and equipment improvement increase quality. Absolute availability and efficiency increase speed

(*Continued*)

TABLE 4.1 (*Continued*)

Zero Waste Relationship to Profit

Key	Zero Waste Goal	Relationship to Profit
9. Product/process engineering	Zero lost opportunity	Early resolution of product design problems with customers and raw materials quality with suppliers significantly reduces cost, while improving quality and cycle time

Note: ROI, return on investment.

Control Points

Control points represent the concept, measures, methods, techniques, Lean tools, and/or business activity that need to be used to assist an organization through the five levels of transformation. This enables an organization to track its progress as it moves through the nine keys. The growth of an organization is measured by the step-by-step development of each key. Productivity, Inc., has developed level-by-level roadmaps for each of the nine keys that help a company select the right Lean tool at the right time. Productivity's full corporate diagnostic table provides progress tables for all of the control points. The progress tables give generic diagnostic questions that will enable you to audit your company at a micro level and rate that unit on a scale of 1 through 5.

How to Score

The purpose of scoring is to rate the unit and the organization objectively in each of the nine keys shown in Table 4.2 and to gain a better understanding of the complex technical and human factors that may affect performance in each control point. Past efforts should be recognized; but as the word diagnosis suggests, the intention of scoring is to point the direction for corrective action and future improvements and, more important, the challenges the organization faces internally and externally. So, it is wise to err on the side of strict application. Diagnosis should lead to a proactive strategic response. This structured *keeping score* process builds in to the Lean management system the core belief of *continuous improvement* and, when used consistently, ensures Lean sustainability.

TABLE 4.2

Shingo Model versus Common Practices

Shingo Model (Beliefs First Approach)	**Common Practices (Tools First Approach)**		
Dimensions	**Principles**	**100's Concepts**	**1000's Tools**
1. Cultural enablers 2. Continuous process improvement 3. Enterprise alignment 4. Delivering results	1. Respect every individual 2. Lead with humility 3. Focus on process 4. Scientific thinking 5. Flow and pull value 6. Quality @ source 7. Seek perfection 8. Create constancy of purpose 9. Think systematically 10. Create value for the customer	1. Waste identification 2. Continuous flow 3. Customer focus 4. Build in quality 5. Just in time 6. Level loading 7. Kaizen, etc.	1. 5S 2. Mistake proofing 3. Kanban 4. Mapping tools 5. Measuring tools 6. Data analysis tools 7. Charting tools 8. Matrix tools, etc.

About the Score

A company that diagnoses itself as a mass production organization will strive to initialize Lean management through focused pilot projects in critical operational areas. Having accomplished this task, management may reassess the company as a level 2 organization. Ascending to the next level requires the company to take what it has learned from its pilot projects and deploy to all major operational areas, the successful completion of which will project the organization to level 3 Lean status. The firm may next face the challenge of extending the new practices into all areas of operations, including support. Ascending to level 4 requires more skill than all previous efforts combined.

Today, only a few organizations can boast of having achieved a level 3 (system development) in all nine keys. Development from levels 1 through 3 is hard work. Going from level 3 to level 4 and from level 4 to level 5 requires sustained management commitment to deploying a Lean management system. The Lean transformation process requires everyone in your organization to adopt a long-term view of applying continuous improvement activities to move the organization through the five levels toward Lean excellence.

Operations Management Model (Shingo)

The Shingo model for operational excellence is based on years of Shingo's teachings on a range of topics relating to continuous improvement. Principles and systems, followed by tools and techniques, are at its core. Shingo describes organizational awareness in terms of four dimensions and 10 principles. Dimension 1: cultural enablers encompass the principles of respect for every individual and leading with humility. Dimension 2: continuous process improvement encompasses principles 3 through 7, focusing on the process to seeking perfection. Dimension 3: enterprise alignment includes principles 8, creating a constancy of purpose, and 9, thinking systematically. Dimension 4 covers delivering results with the singular principle of "creating value for the customer." Using this type of a "beliefs first approach" and creating Lean organizational awareness is what the Lean Management System Handbook will help you understand and implement.

Like many models, the Shingo model contains a guiding assessment that provides both baseline and scorecard for your Lean transformation process. An important key for the Shingo model is that it includes a robust behavior assessment focused on Lean management operational philosophy, beliefs, and behaviors. This behavior assessment is used to systematically audit senior leadership, managers, and associates with a level 5 Lean understanding and participation scale that ranges from <20% on the novice end (non-Lean behaviors) to >80% on the mature (Lean behaviors). It stresses a long-held philosophy of the authors that beliefs drive behaviors and non-Lean beliefs drive non-Lean behaviors. This assessment becomes a roadmap for increasing organizational Lean awareness and driving the behaviors for true Lean behaviors. Each year, participating organizations committed to learning and living this model are awarded Shingo Prizes* for achievement levels of bronze, silver, and gold.

Shingo Model versus Common Practices

The Lean journey can indeed be mostly a rocky road under your bare feet for the seasoned Lean practitioner operating in a traditional organization. Most organizations' first introduction to Lean is through tools. A common practice and initial management belief when superficially introduced to Lean is if we introduce some employees to a couple of Lean concepts with tools training, do a few Kaizens, and we are Lean. The story has been told

* The Shingo Prize for operational excellence, www.shingoprize.org.

countless times of companies that either believe that they are now Lean after a few Kaizens or tried the approach and did not get the results that others claimed were attainable.

Table 4.2 shows the stark contrast in approaches between the Shingo model, a belief and behavior based system, and common practice, which is a tools first approach. Contrary to the common practice approach, the Shingo model begins by teaching beliefs, which drive behaviors, which in turn will drive organizational performance.

In developing your Lean management system, it is possible to integrate some of the critical and fundamental aspects of each of these models. Table 4.3 highlights some of the complementary thoughts of each model.

TABLE 4.3

Integrated System Approach

Jackson	**Senge**	**Shingo**[a]
Customer focus	You can have your cake and eat it too—but not at once, without guilt or blame	The mission of the Shingo Prize is to create a customer focus of excellence in organizations through the application of universally accepted principles of operational excellence, alignment of management systems, and the wise application of improvement techniques across the entire organizational enterprise
Leadership and strategic planning	Dividing an elephant in half does not produce two small elephants	Lean strategic planning and deployment, as a leader, personally engage in the Lean transformation process, beyond delegation and project management, so that performance improvements do not plateau and true cultural transformation takes place
Organization architecture	The easy way out usually leads back in	Shingo examines how the organizational elements work together to build the culture of continuous improvement
Lean supply chain	Faster is slower; cause and effect are not closely related in time and space	Shingo helps supply chain leaders understand how to go beyond the application of Lean tools and create an organization that embodies the culture of continuously improving customer value and eliminating waste
Information architecture	Small changes can produce big results—but the areas of highest leverage are often the least obvious	The Shingo Prize enhances information architecture by teaching correct principles and new paradigms that accelerate the flow of valuable information, align and empower people, and transform organizational culture

(*Continued*)

TABLE 4.3 (*Continued*)

Integrated System Approach

Jackson	Senge	Shingo[a]
Production management	The cure can be worse than the disease	Standard work and visual management; **t**he Shingo paradigm is that there is a clear and strong relationship between production principles, systems, and tools
Equipment/process management	Today's problems come from yesterday's solutions	Shingo adds a *proactive* improvement cycle that sets out to look for trouble by isolating equipment/processes for analytical purposes and measuring and then balancing inputs and outputs to force all wastes to become visible
Product/process engineering	The harder you push, the harder the system pushes back	Shingo helps to recognize how to engineer and unlock the potential demonstrated in the islands of improvement in the company and tie them together into an entire value stream of people focused on improving flow each and every day

[a] The Shingo Prize and its study tours are designed to open your eyes, broaden your vision, and deepen your understanding of how the principles of operational excellence are being applied around the world. Participants get a firsthand experience on how the principles of operational excellence are being applied by visiting several Shingo recipient companies among others. Participants will gain a deeper understanding of how to define principle-based behavior and what to look for. Participants will also understand the key elements of behavior as we further discuss and look at what drives the behavior, the system in place. These tours create a new lens for many to truly see beyond the tools and discover what are at the roots of great continuous improvement cultures.

SUMMARY

This chapter presents an overview of the elements that comprise the Lean management system and an examination of how they work together to create a system of continuous improvement through collaborative problem solving. As we described, traditional management systems are largely based on systematically disassembling the functions of the organization and then managing the performance of each piece in short time increments. This approach assumes that the performance of the whole is usually represented by the sum of the parts. Performance abnormalities are often viewed as shortfalls, and managers are expected to lead problem analysis and demonstrate proficiency at having bright ideas by knowing all the answers.

Lean organizations, on the other hand, depend on systematically developing the problem-solving capabilities of the entire workforce by allocating specific categories of problems to each layer of the organization, starting with the strategic level, down through the process and work unit levels, and culminating at the individual level. Although there is still a need for deep expertise in specialty departments, the primary emphasis in a Lean environment is on process performance of the entire value stream and the customer that it serves. Leadership in this type of organization is less focused on being the problem solver and more focused on building the problem-solving muscle of the workforce. Although traditional organizations delegate problem solving to 10%–20% of the workforce, Lean organizations endeavor to have the entire organization actively engaged in problem solving.

We present the fundamental composition requirements of your Lean management system in our education–application–communication prism model. In addition, we also describe three current approaches of learning management, strategy management, and operations management models. Depending on your organization's current understanding and awareness of Lean, elements of each of these can be adapted as needed to achieve your final Lean management model. More importantly, details of your Lean management system will emerge as you move through this handbook: in Chapters 5 through 10, we describe in detail a wide range of content that will shape your final Lean management system.

REFERENCES

1. James P. Womack, Daniel T. Jones, and Daniel Roos. *The Machine That Changed the World,* Simon and Schuster, New York, 2007. Also see Matthias Holweg, "The Genealogy of Lean Production," *Journal of Operations Management* 25(2), 420–437, 2007.
2. Thomas Jackson, *Corporate Diagnosis*, Productivity Press, Portland, Oregon, 1996.

5

Lean Socio-Technical System: On Developing a Lean Culture

> Faced with the choice of changing one's mind and proving that there is no need to do so, almost everybody gets busy on the proof.
>
> **John Kenneth Galbraith**

IN A NUTSHELL

A social system is the backbone of employee relationships across your organization. It mandates a code of conduct or behavior for all employees; management and staff alike. Many organizations prepare mission, vision, and values (MVV) statements as a foundation of the code of conduct that employees are expected to adopt. They are a symbol of an organization's desire to set a direction and boundary guidelines for a structured set of beliefs and behaviors. However, MVV are delicate in nature and easily disrupted. Unfortunately, even in organizations with the best intentions, many behaviors contrary to the MVV are often observed and can destroy a social system structure essential for a Lean management system to emerge. In fact, it can be argued that it is easy for a social system to collapse, when employees recognize that management is ignoring the MVV due to a conflict with some non-Lean business driver or measurement system. If management does not walk the talk of Lean, they cannot expect that their employees will.

OVERVIEW

It has been stated that "the act of observing something changes it." This is commonly referred to as the Hawthorne effect based on a research project

(1927–1932) of the Hawthorne plant of the Western Electric Company in Cicero, Illinois. First led by Harvard Business School professor Elton Mayo along with associates F.J. Roethlisberger and William J. Dickson, this research started out by examining the physical and environmental influences of the workplace (e.g., brightness of lights and humidity) and later, moved into the psychological aspects (e.g., breaks, group pressure, working hours, and managerial leadership). However, it was the many ideas that this team developed about the social dynamics of groups in the work setting that had lasting influence, such as the collection of data, labor–management relations, and informal interaction among factory employees.

One of the primary findings of this research was that the workplace was a social system made up of interdependent parts. It also found that the relations between management or supervisors and workers influenced the way work was carried out in that social system.

The social system performance determines organizational performance and although it is influenced by many factors, it is individual employee *belief systems*, *measurement systems*, and underlying employee *fear* that are the fundamental drivers for all employee behavior. Understanding and modifying these three critical components of your organization will dictate your success in developing a Lean socio-technical system.

In keeping with the highest law of Lean, that is to identify and eliminate waste, the purpose of this chapter is to identify waste and some underlying root causes of social system waste in organizations today. In fact, one of the most observed behaviors in social systems today is that management believes that implementing Lean consists of simply exposing employees (not management) to Lean tools and techniques. The most important group in any organization embarking on a Lean transformation is the management group. Converting a management group to a Lean thinking is critical to creating a Lean management system.

A Lean management system must be supported by Lean culture and social system, where all employees embrace a new Lean approach to

- Believing
- Measuring
- Thinking
- Acting
- Leading
- Teaching

- Coaching
- Managing
- Working together
- Treating fellow employees fairly

Before we can develop any of these employee attributes in our organization, we must first somewhat understand the human component: who we are as individuals, what drives our behavior, and the often hidden but critical human factors that support a Lean management system. We begin this chapter with a discussion of *employee behavior drivers*. This is a brief glimpse into the visually observed macrobehavior of all employees on a daily basis. What drives employee behavior, and why do they do what they do?

Lean Culture Defined

The definition of a Lean culture probably varies by company and is dependent on how they define Lean. Lean can be defined in terms of waste elimination, improvements in the value of products and services to the customers, cost reductions, and so on, or in terms of any improvements in any process, internal or external to a company, that will help it to achieve its profitable revenue growth goals.

A Lean culture would then consist of the beliefs and behavior characteristics of employees that understand what their company's goals and objectives are, why they are important, understand the purposes of Lean improvements, have had the necessary Lean tools and techniques training to effect improvements, and are then given a reasonably free hand to do so on an ongoing basis. Being Lean begins with culture and leadership, although it cannot end with that. Unfortunately, many Lean initiatives, in an effort to create the appearance of immediate or dramatic changes to return on investment (ROI), focus only on the tools. There is no doubt that the *tools only* approach of conducting some quick training and a few Kaizen blitzes can yield substantial short-term results, such as inventory reduction, cycle time reduction, or other short-term financial rewards. However, this view of Lean misses the essence of what it means to be a Lean organization and, more importantly, is not sustainable, which is one of the reasons why a large percentage of Lean transformations fail, and why there are very few real Lean companies in the United States and even in Japan.

A true Lean transformation must begin with the people. This starts with the senior management group. First and foremost, management's

highest responsibility is to adopt and live Lean on a daily basis. Second, possible Lean leaders must be identified—those that can initially drive Lean and communicate a complete distaste for all forms of waste in everything they do—and also be empowered to make quick changes. Once Lean is under way all employees will have to be brought into the fold. They need to be trained on how to recognize waste, how to use the tools to drill down to the underlying causes of waste, and how to get rid of it.

Creating a Lean culture means everyone in the organization has a single unified goal of creating value for the customer. It is not top-down management, rather, it is bottom-up management for senior management has to release the creativity of its workforce, supply every tool possible to make sure the workforce has the ability to drive value, and then get out of the way. Why do so many attempts to create a Lean culture fail? Because most managers think they know everything there is to know about their organization and implement Lean as some sort of control mechanism over the workers, rather than creating what Lean truly is; a process management system that is controled by the workers.

Psychological Human Needs

In that basic *needs* are manifested by employees at all levels of the organization, we have found the current state of employees as typically struggling at the esteem, respect, achievement, and confidence level on Maslow's hierarchy of needs. These are often portrayed in the shape of a pyramid, with the largest and lowest levels of needs at the bottom, and the need for self-actualization at the top. The lower four layers of the pyramid contain what Maslow called *deficiency needs* or *d-needs*: physiological, security of position, friendship and love, and esteem. With the exception of the lowest (physiological) needs, if these *deficiency needs* are not met, the body gives no physical indication but the individual feels anxious and tense.* Addressing these needs becomes the primary objective and challenge for the social system development. How do we create an atmosphere in the

* Maslow's hierarchy of needs is a theory in psychology, proposed by Abraham Maslow in his 1943 paper *A Theory of Human Motivation*. Maslow subsequently extended the idea to include his observations of humans' innate curiosity. His theories parallel many other theories of human developmental psychology, all of which focus on describing the stages of growth in humans. Maslow studied what he called exemplary people such as Albert Einstein, Jane Addams, Eleanor Roosevelt, and Frederick Douglass rather than mentally ill or neurotic people, writing that "the study of crippled, stunted, immature, and unhealthy specimens can yield only a cripple psychology and a cripple philosophy." Maslow also studied the healthiest 1% of the college student population. Maslow's theory was fully expressed in his 1954 book *Motivation and Personality.*

organization that fosters individual employee growth and both encourages and supports an employee's improved esteem; level of respect by subordinates, peers, and supervisors; an ever-evolving road for individual employee achievements; and freedom to act with confidence in a continuous improvement environment? It just so happens that creating this type of personal growth environment is consistent with achieving a Lean management system.

Let us further discuss basic *Management Theories* and take a fundamental look at Theory X (approximate traditional philosophy) and Theory Y (approximate Lean philosophy) as organizational beliefs. Because management is faced with the same personal growth issues on the hierarchy of needs as all employees, they face a more difficult and critical challenge than rank and file. First, they must learn how, where, when, and why they are currently using traditional beliefs. Management must absorb how traditional beliefs negatively impact their organization and hinder adoption of Lean management system.

Concurrently, they must purge the old traditional beliefs, adopt the new Lean beliefs, and alter their behavior to live these new Lean beliefs on a daily basis.* To this end, the chapter will present a systematic methodology for changing your organization's belief system. This is the foundation of transforming your organization's social system to support and nurture a culture that can achieve a Lean management system. The goal theories presented are very process oriented in nature. Approach and avoidance goals are viewed as exerting their different effects on achievement behavior by activating opposing sets of motivational processes.[1]

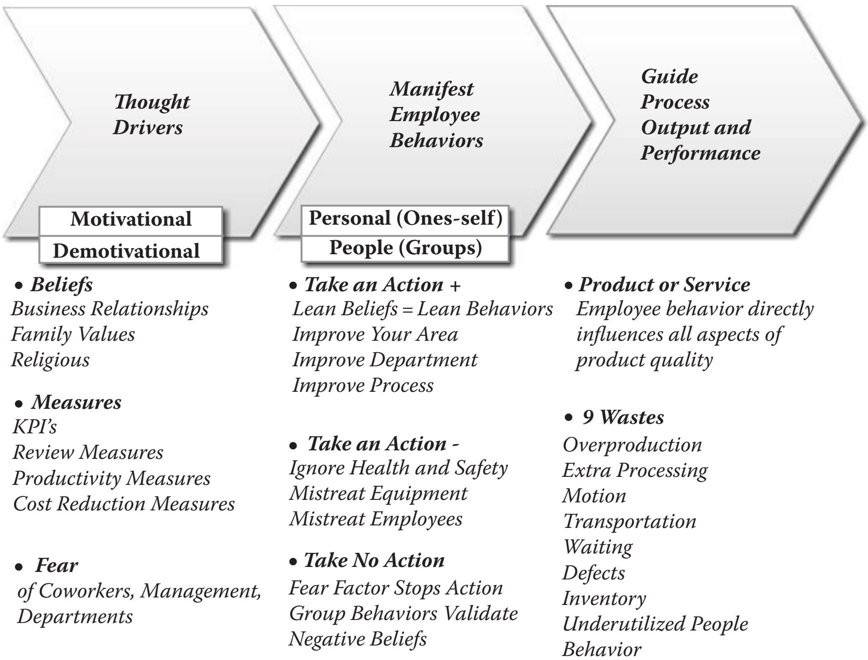
EMPLOYEE BEHAVIOR DRIVERS

People operate every day and make decisions based on a lifelong set of beliefs that have been developed over time. We are constantly creating new beliefs based on our daily interactions with everything around us.

* Various Lean motivational goal theories have recently been proposed based on the trivariant framework by achievement goal theorists: mastery, performance-approach, and performance-avoidance. Performance-approach and mastery goals both represent approach orientations according to potential positive outcomes, such as the attainment of competence and task mastery. These forms of behavior and self-regulation commonly produce a variety of affective and perceptual-cognitive processes that facilitate optimal task engagement. They challenge sensitivity to information relevant to success and effective concentration in the activity, leading to the mastery set of motivational responses described by achievement goal theorists.

These beliefs are based in religion; culture; relationships with our parents, friends, relatives, coworkers, pets; and our past work environment, to name a few. The result is that we have many beliefs that drive our daily behavior and our reaction to the surrounding set of circumstances we face.

Adopting a Lean philosophy is much more than learning a set of new tools. It is about adopting a new belief system, one that is rooted in a Lean operational philosophy. The difficulty with this is that most often people hold on tightly to their beliefs and are reluctant to change them. This is especially true of management. Typically the higher up in the organization you go, the more difficult it is to change one's philosophy or belief system.



Measures Drive Behavior

Measures are one of the three primary forces driving employee behavior. Developing a true Lean measurement system is not only one of the foundations of a Lean management system but also a key component in promoting Lean behaviors.* Similarly, many social system considerations

* The Shingo model presents an organizational set of measures that direct, encourage, and support the deployment of a true Lean management system.

are guided with a Lean measurement system. In fact, most traditional managers consider measures as the primary means of altering employee behavior. As a consequence, many organizations put in place a myriad of measurements expected to steer employees toward organizational objectives or limit resource expenditures.

We have one caveat to add, however: "be careful what you measure." Since we know measures drive behavior and non-Lean measures drive non-Lean behavior. In many instances, these measures are contrary to a Lean philosophy and are

- Aligned vertically in the organization and get employees at all levels looking and focusing vertically in the organization, rather than horizontally across the organization where all value is created for the customer.
- Dead cost measures which do not reflect either effective service or quality product delivery to the customer.
- *Internally focused* on your organization rather than being *externally focused* on the customer.
- Measurements that are not connected to process performance.
- Measures that do not distinguish between good costs and bad costs.
- Measures that indicate management's negative view of employees in general.

Most traditional organizations use traditional measures. Unfortunately, most of these are dead cost measures. By dead cost we mean they are not tied to customer requirements for organizational performance. Measures such as number of employees, cost or raw materials, and number of units produced are examples of dead cost measures. It is acceptable to monitor these measures; however, they should not be true business drivers. During a transformation to a Lean management style, dead cost measures should be replaced with customer-focused performance measures as business drivers. These are recognized by their external focus on customer requirements (e.g., lead time, or on-time in-full, and in-specification). An example of non-Lean management philosophy is to set a manpower level measurement regardless of the manpower level needed to meet customer requirements. This is commonly referred to as management by headcount. It is an internally focused management style that can often make it difficult or impossible to deliver in accordance with customer requirements.

Beliefs Drive Behavior

No matter what level in the organization, individual beliefs drive behavior. For management, those beliefs shape the entire organization. Their management style, how they interact with subordinates, how they set policy and procedure, and how they develop organizational measurement systems, all shape the overall management system.

- Do you believe that people are trustworthy?
- Do you believe that people seek responsibility and accountability?
- Do you believe that people seek meaning in their work?
- Do you believe that people naturally want to learn?
- Do you believe that people do not resist change but they resist being changed?
- Do you believe that people prefer work to being idle?

How you answer these fundamental questions defines your beliefs regarding employees and indicates what type of management style you will project from your position in the organization. Primarily positive responses to the questions and you tend toward Theory Y management philosophy, primarily negative responses to the questions and you tend toward Theory X management philosophy. A Theory Y management philosophy is a fundamental component of a Lean management system.

Motivation Defined

Motivation is the basic drive for all our actions. Motivation refers to the dynamics of our behavior, which involves our needs, desires, and ambitions in life. Achievement motivation is based on reaching success and achieving all our aspirations in life. Achievement goals can affect the way a person performs a task and represent a desire to show competence. These basic physiological motivational drives affect our natural behavior in different environments. Most of our goals are incentive-based and can vary from basic hunger to the need for love and the establishment of mature sexual relationships. Our motives for achievement can range from biological needs to satisfying creative desires or realizing success in competitive ventures. Motivation is important because it affects our

lives each and every day. All our behaviors, actions, thoughts, and beliefs are influenced by our inner drive to succeed.*

Motivation as the Driving Force

As previously mentioned, employee motivation can be defined in a number of ways. Generally, it is defined as a driving force that initiates and directs behavior. In other words, motivation is a kind of internal energy that drives a person to do something to achieve something. It is a temporal or dynamic state within a person, which is not concerned with his/her personality. There are different types of motivation such as achievement motivation, affiliation motivation, competence motivation, power motivation, and attitude motivation.

Motivation is based on three specific aspects: awakening of behavior, direction of behavior, and persistence of behavior. Awakening of behavior involves what activates human behavior, whereas direction of behavior is concerned with what guides behavior toward a specific goal. Persistence of behavior is concerned with how the behavior is sustained.

Various studies have been conducted to understand the different motives that drive a person to success. Motives are categorized into three areas: homeostatic motives, nonhomeostatic motives, and learned or social motives. Almost all the motives belong to one or more of these three groups.

Motives such as thirst, hunger, respiration, and excretion are included in homeostatic motives. Nonhomeostatic motives include required activities such as seeking shelter and curiosity about the environment. Curiosity, a desire for novelty, power, achievement, social affiliation, and approval are considered as learned motives or social motives.

Motivation is essential to be successful in any endeavor you undertake. It can be positive or negative, subtle or obvious, tangible or intangible. It is very important in workplaces as it plays a key role in the effective performance

* Motivational researchers share the view that achievement behavior is an interaction between situational variables and the individual subject's motivation to achieve. Two motives are directly involved in the prediction of behavior, implicit and explicit. Implicit motives are spontaneous impulses to act, also known as task performances, and are aroused through incentives inherent to the task. Explicit motives are expressed through deliberate choices and more often stimulated for extrinsic reasons. Also, individuals with strong implicit needs to achieve goals set higher internal standards, whereas others tend to adhere to the societal norms. These two motives often work together to determine the behavior of the individual in direction and passion.

of employees. In industry, managers play a significant role in employee motivation. They use different motivation techniques to improve productivity, thereby promoting cooperation between employees and employers. Learning is somewhat interrelated to motivation. In education, instructors also use motivation techniques to motivate the students to learn. It is essential to activate student motivation as it can make a student more competent. Also, motivation encourages self-confidence and problem-solving skills.

Fear Drives Behavior

When we say fear drives behavior, we do not mean that employees walk around all day in fear of their jobs. (Although this is the case in some companies.) But rather that there is an underlying latent *fear* of taking action to improve current processes. These fears result from your organizational environment and consist of the following beliefs:

- My boss will not like that.
- The next department wants it this way.
- Our company policy is that we do not change anything without authorization from …. (You fill in the blank.)

All of these *fears* drive employer behavior and stifle employees from taking positive actions that could help the organization deliver value for the customer.

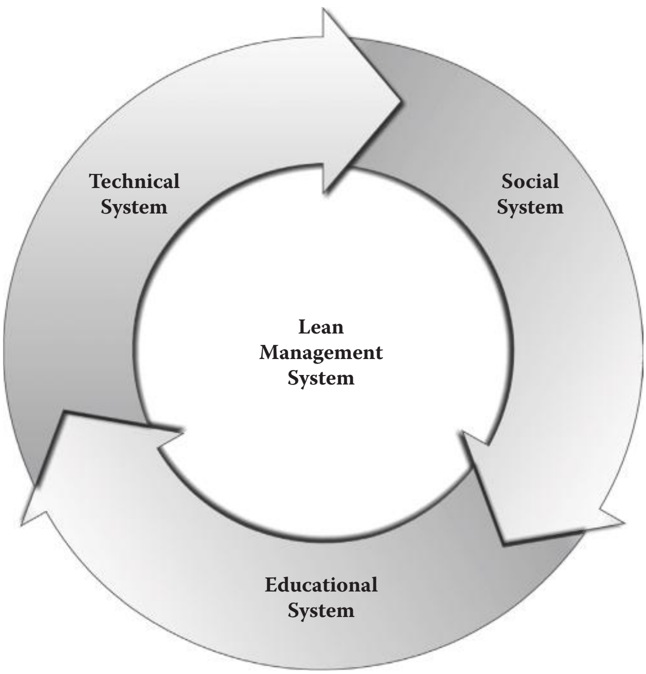
RULES OF TRANSITION:

FEAR OF FAILURE VERSUS SHARED SUCCESS

Traditional organizations: Employees sometimes live in fear of failure, which stifles them and strangles company productivity and profitability. Fear is a powerful motivator that can completely stop employee participation in continuous improvement. Management demeanor and communication with employees at all levels can create this *fear environment*.

Lean organizations: Managers promote a *no fear* work environment. This leads to improvement experimentation and shared successes between employees at all levels.

Fear can directly or indirectly flow from management through organizational procedures, policies, and mind-sets that inhibit creativity and innovation. Creativity and process innovation are the essence of a Lean change + improve culture. In a fully mature Lean management system, this latent fear is completely eliminated. A comprehensive set of Lean measures replaces traditional measures and the new Lean management system aligns the socio-technical, educational, and change management beliefs and measures. The result is a fear-free environment where creativity, innovation, and daily process improvement can flourish.*



* Explicit and implicit motivations have a compelling impact on behavior. Task behaviors are accelerated in the face of a challenge through implicit motivation, making performing a task in the most effective manner the primary goal. A person with a strong implicit drive will feel pleasure from achieving a goal in the most efficient way. The increase in effort and overcoming the challenge by mastering the task satisfies the individual. However, the explicit motives are built around a person's self-image. This type of motivation shapes a person's behavior based on their own self-view and can influence their choices and responses from outside cues. The primary agent for this type of motivation is perception or perceived ability. Many theorists still cannot agree whether achievement is based on mastering one's skills or striving to promote a better self-image. Most research is still unable to determine whether these different types of motivation would result in different behaviors in the same environment.

Hierarchy of Needs

As previously described, Abraham Maslow is one of the original founders of a theory on human motivation. His theory defines humans as motivated by unsatisfied needs. Although many have offered modifications or clarifications over the years, this theory remains fundamentally true for all employee behavior. Maslow's hierarchy of needs is illustrated on the chart and includes physiological, safety, love/belonging, esteem, and self-actualization needs. The philosophy puts forth that the basic needs at each level must be met before a human is motivated by the needs at the next level. In other words, after a basic need is satisfied it stops acting as a primary motivator and the individual will begin to be motivated by the next level until the individual is motivated by self-actualization concepts.

As shown in the pyramid, achievement motivation can be conceptualized in many different ways. Our understanding of achievement-relevant effects, cognition, and behavior has improved. Despite being similar in nature, many achievement-motivation approaches have been developed separately, suggesting that most achievement motivation theories are in concordance with one another instead of competing. Motivational researchers have sought

to promote a hierarchal model of approach and avoidance as achievement motivation by incorporating the two prominent theories: the achievement motive approach and the achievement goal approach. Achievement motives include the need for achievement and the fear of failure. These are the more predominant motives that direct our behavior toward positive and negative outcomes. Achievement goals are viewed as more solid cognitive representations pointing individuals toward a specific end.

There are three types of these achievement goals: a performance-approach goal, a performance-avoidance goal, and a mastery goal. A performance-approach goal is focused on attaining competence relative to others, a performance-avoidance goal is focused on avoiding incompetence relative to others, and a mastery goal is focused on the development of competence itself and of task mastery. Achievement motives can be seen as direct predictors of achievement-relevant circumstances. Thus, achievement motives are said to have an indirect or distal influence, and achievement goals are said to have a direct or proximal influence on achievement-relevant outcomes (Elliot and McGregor 1999).*

Most employees today meet the basic physiological, safety, and love/belonging needs. However, employees in many organizations today are struggling at the esteem level. Their personal self-esteem may not be as high as they would like. Their level of achievement at work is not up to their expectations. They do not feel respected by others and often have little respect for management. As a consequence, they are neither confident nor comfortable in their positions. The relative inability of employees to achieve these fundamental esteem objectives defines their extent of job satisfaction and happiness. This defines the common underlying social system problem in many organizations that must be addressed for true Lean management to exist and flourish.

What does Maslow's hierarchy of needs chart mean for organizational management? Most process improvement projects breakdown because employee's basic esteem level needs are not being met. They have difficulty performing in teams. A key challenge for all management is to create an environment that allows employees to meet these basic esteem needs

* According to Elliot and McGregor (1999)[2], these motives and goals are viewed as working together to regulate achievement behavior. The hierarchal model presents achievement goals as predictors for performance outcomes. The model is being further conceptualized to include more approaches to achievement motivation. One weakness of the model is that it does not provide an account of the processes responsible for the link between achievement goals and performance. As this model is enhanced, it becomes more useful in predicting the outcomes of achievement-based behaviors.

and to move on to self-actualization needs. Most process improvement activities are completed by employees that operate on the esteem or self-actualization level. This is where creativity, problem solving, spontaneity, morality, and lack of prejudice are motivators for employees. These are also the motivations required to conduct and implement any comprehensive process improvement program. Managements' primary goal is to develop a philosophy and style that promotes employee involvement and empowerment.*

THEORY X AND THEORY Y MANAGEMENT PHILOSOPHIES

Many books have been written on the subject of management philosophy. Figure 5.1 shows the two fundamental management theories originally developed by Douglas McGregor. His work was based on

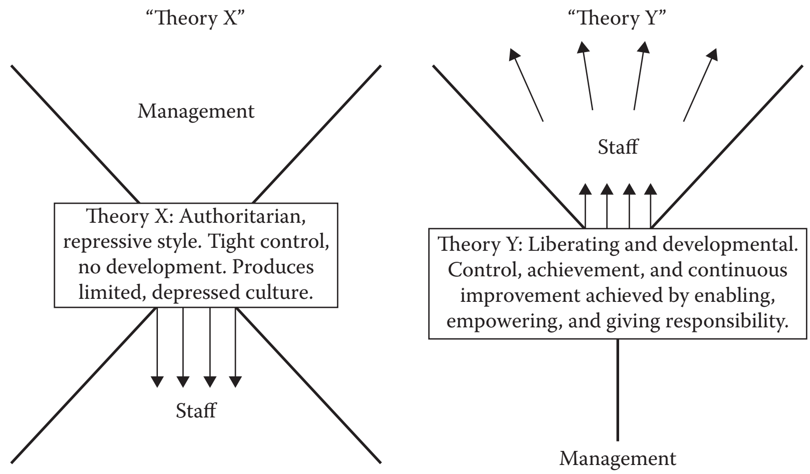


FIGURE 5.1
Theory X and Theory Y management beliefs.

* Theorists have proposed that people's achievement goals affect their achievement-related attitudes and behaviors. Two different types of achievement-related attitudes include task involvement and ego involvement. Task involvement is a motivational state in which a person's main goal is to acquire skills and understanding, whereas the main goal in ego involvement is to demonstrate superior abilities. One example of an activity where someone strives to attain mastery and demonstrate superior ability is schoolwork. However, situational cues, such as the person's environment or surroundings, can affect the success of achieving a goal at any time.

RULES OF TRANSITION:

BLAME PEOPLE VERSUS IMPROVEMENT OPPORTUNITIES

Traditional organizations: Management blames people when things do not go according to the Theory X command and control plan. Searching for the guilty is a less-than-desirable practice that reinforces the fear of failure and brings employees' creativity and innovative skills to a screeching halt. In essence, employees begin doing only those activities that they are commanded to do.

Lean organizations: When a difficult situation or problem is surfaced, managers view this as an *improvement opportunity* and engage employees to find solutions to improve the situation. Lean managers show the importance they place on the problem by supporting and assisting employees with improvement initiatives.

the psychology research and writings of Abraham Maslow discussed in the section on "Hierarchy of Needs." Theory X is an authoritarian approach, top-down command and control that contain beliefs that people need tight controls. Theory X management looks at employees as inherently lazy, like to avoid responsibility, and need to be controlled and/or driven by fear. This creates a somewhat stifling environment. Conversely, Theory Y management philosophy, based on Maslow's hierarchy of needs, looks at employees as people that inherently want to do a good job, they seek challenges and responsibilities, and can drive themselves better than management can. Theory Y management fosters an empowered employee environment, where learning, creativity, and improvement are valued.*

* Self-worth theory states that in certain situations people stand to gain by not trying and deliberately withholding effort. If poor performance is a threat to a person's sense of self-esteem, this lack of effort is likely to occur. This most often occurs after an experience of failure. Failure threatens self-estimates of ability and creates uncertainty about an individual's capability to perform well on a subsequent basis. If the following performance turns out to be poor, then doubts concerning ability are confirmed. Self-worth theory states that one way to avoid threat to self-esteem is by withdrawing effort. Withdrawing effort allows failure to be attributed to lack of effort rather than low ability, which reduces overall risk to the value of one's self-esteem. When poor performance is likely to reflect poor ability, a situation of high threat is created to the individual's intellect. On the other hand, if an excuse allows poor performance to be attributed to a factor unrelated to ability, the threat to self-esteem and one's intellect is much lower.

Theory X is often referred to as a traditional organization, whereas all world class or Lean organizations practice a Theory Y management style. The remainder of this chapter points out some differences between traditional organizational approaches and Lean organizational approaches.

KEY SOCIAL SYSTEM IMPLEMENTATION CHALLENGES

Transforming an organization into a Lean management environment is a complex and difficult challenge. For years, Maslow and McGregor debated and refined management theory based on fundamental human needs. Their research is alive and well today and just as pertinent as it was from 1960s to the 1990s. Results of recent studies conducted by Deloitte Development LLC on the top issues facing organizations during process improvement implementations show that 62% or a majority of improvement initiatives fail due to people-related issues. The root causes of these failures can be traced to the fundamental nature of management (Theory X or Theory Y) and employee belief systems that drive motivation and ultimately their daily behavior (Figure 5.2).*

Table 5.1 shows a number of general beliefs or attributes held by management and employees of both traditional and Lean organizations. A range of these beliefs is held by employees at all levels in your organization. It should be noted that the dominant beliefs of the management team by default become the beliefs of employees more or less. Organizations that hold on to traditional beliefs can *never* achieve Lean management or operation.

First, Management must be committed to this transformation from traditional beliefs to Lean beliefs. Both management and employees in the organization have to begin to let go of old ways as they are learning their new belief system. Second, they have to be willing to begin to change their belief system to adopt new Lean ideas and concepts. Third, they need to

* Recent studies have been conducted involving unsolvable problems to test some assumptions of the self-worth theory regarding motivation and effort. The results showed that there was no evidence of reported reduction of effort despite poorer performance when the tasks were described as moderately difficult as compared with tasks much higher in difficulty. The possibility was raised that low effort may not be responsible for poor performance in situations that create threats to self-esteem. Two suggestions were made, one being that people might unconsciously withdraw effort, and the other stating that they may reduce effort as a result of withdrawing commitment from the problem. Regardless of which suggestion is true, self-worth theory assumes that individuals have a reduced tendency to take personal responsibility for failure.

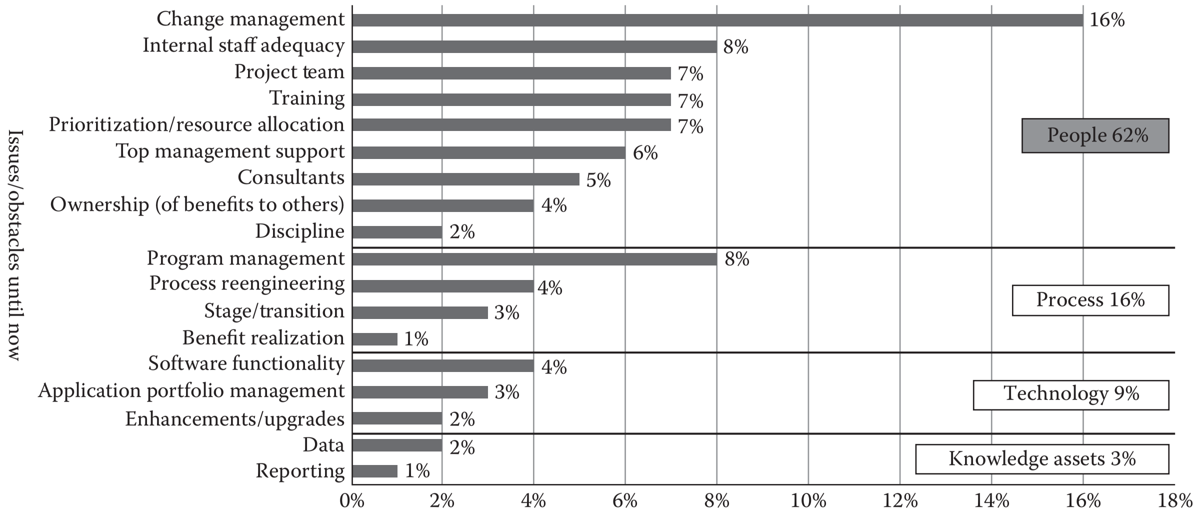


FIGURE 5.2
Top issues facing organizations during process improvement implementation: Traditional versus Lean beliefs. Over half of large-scale technology projects fail because inadequate attention is paid to people-related issues. Rounded percentages; 10% of categories are not shown as bars. (Copyright 2006 Deloitte Development LLC. All rights reserved.)

TABLE 5.1

Traditional Organizational Beliefs versus Lean Organizational Beliefs

Traditional Organization	Lean Organization
Functional focus	Business focus
Management directs	Managers teach
Delegate	Support
Forecast driven	Customer driven
Fear of failure	Share success
Blame people	Improvement opportunities
Heroes and goats	Real teams
Us vs. them	Community
Results focus	Process focus
Me (producer)	You (customer)
Dedicated equipment	Flexible equipment
Slow changeover	Quick changeover
Narrow skills	Multiskilled
Managers control	Workers control
Pure production environment	Learning environment
Supplier is enemy	Supplier is ally
Guard information	Share information
Customer as buyer	Customer as resource
Linear design	Concurrent design
Volume lowers cost	Analyze cost drivers
Internal focus	External focus
Shallow process knowledge	Deep process knowledge
Quality problem detection	Quality problem prevention
Hierarchy	Flat organization
Short-term thinking	Balanced thinking
Worker accountability	Executive accountability
Rewards money	Rewards pride then money
Competition	Cooperation
Complex	Simple

learn how to live Lean on a daily basis going into the future. This becomes a more significant challenge in the environment where a number of fellow employees may be reluctant to change their beliefs.

Rules of Transition are presented throughout the book and further compare and contrast managements' approach in traditional organizations and Lean organizations. These rules were developed for transitioning from a traditional organization to a Lean organization. These help describe what it means to operate in a Lean management environment. These Rules

RULES OF TRANSITION:

MANAGEMENT DIRECTS VERSUS MANAGERS TEACH

Traditional organizations: Focus on directives for departments, and employees. This is commonly referred to as *top-down* or *command and control* management.

Management directs and controls initiatives, projects, and employees. Management knows all, sees all, hears all, and controls all.

Lean organizations: Managers act as teachers, coaches, and mentors for employees. They teach employees Lean concepts and tools and allow them to apply these concepts and tools within the context of their position. This is commonly described as an empowered employee environment. Employees understand company MVV and all organizational measures are aligned with customer expectations. Employees are the primary drivers of process improvement, service delivery, and product quality.

of Transition are presented throughout this book in stand-alone boxes as a series of reminders and independent thoughts that should help you to adopt these new beliefs and incorporate them into your daily activities.*

Two Rules of Transition are presented here that are critical to any Lean management transformation process. These are focused specifically at aspects of management's belief system that often severely restrict improvements in product quality, employee productivity, and company profitability.

Transitioning a manager's beliefs and role from that of a director to that of a teacher, coach, and mentor is a significant step and a daunting challenge for many organizations. However, it is essential to achieve the

* In everyday life, individuals strive to be competent in their activities. In the past decade, many theorists have utilized a social-cognitive achievement goal approach in accounting for individuals striving for competence. An achievement goal is commonly defined as the purpose for engaging in a task, and the specific type of goal taken on creates a framework for how individuals experience their achievement pursuits. Achievement goal theorists commonly identify two distinct ideas toward competence: a performance goal focused on demonstrating ability when compared to others, and a mastery goal focused on the development of competence and task mastery. Performance goals are hypothesized to produce vulnerability to certain response patterns in achievement settings such as preferences for easy tasks, withdrawal of effort in the face of failure, and decreased task enjoyment. Mastery goals can lead to a motivational pattern that creates a preference for moderately challenging tasks, persistence in the face of failure, and increased enjoyment of tasks.

RULES OF TRANSITION:

FUNCTIONAL FOCUS VERSUS BUSINESS PERFORMANCE FOCUS

Traditional organizations: Focus on functions, departments, and employees as vertically aligned independent entities. Many traditional measures on these functional areas are viewed in a tunnel without consideration of customer requirements. As a consequence, these measures are often conflicting and the organization ends up rewarding behavior by the employee, function, or department that is not aligned with customer requirements.

Lean organizations: Focus on business performance from the customer viewpoint. All organizational value-added functions, departments, and employee activities are linked together as one horizontal integrated business performance unit, where products and services flow naturally toward the customer. All organizational performance measures roll up to well-defined critical-to-quality customer requirements.

Theory Y environment previously described and imperative if an organization is to effectively implement a Lean management philosophy. Begin creating the manager as teacher/mentor environment and promote Lean learning and practices at all levels of the organization.

Transitioning management from a functional focus to a business performance focus is a significant challenge; however, this can reap exceptional rewards. In non-Lean organizations, employees have a functional focus and many measures that result in them losing sight of the connection between their activities and customer requirements. Management's challenge is to

- Minimize or eliminate barriers that emerge from being a *vertically* aligned and functionally focused organization.
- Foster an environment where all activities aligned *horizontally* along the value stream are viewed by management and employees as one continuous value stream.
- Create individual, departmental, and divisional measures that align with customer requirements and roll up to strategic organizational business objectives.

SUMMARY

Motivation can be defined as the driving force behind all the actions of an individual and is a key component of a Lean organization. The influence of an individual's needs and desires has a strong impact on the direction of their behavior. The key in a Lean management system is to understand the basics of what drives employee behavior. Our challenge as managers in an evolving Lean Management System is to recognize in ourselves the Theory X and Theory Y attributes we pass along to our employees every day and strive to eliminate Theory X behavior whenever we recognize it. Our willingness to adopt Lean beliefs and behaviors and promote those attributes in our employees will help drive our organization toward a Lean environment.

Motivation is based on your emotions and achievement-related goals. There are different forms of motivation including extrinsic, intrinsic, physiological, and achievement motivation. There are also more negative forms of motivation. Achievement motivation can be defined as the need for success or the attainment of excellence. Individuals will satisfy their needs through different means and are driven to succeed for varying reasons both internal and external.

Motivation is an important factor in everyday life and a critical component of Lean thinking. Our basic behaviors and feelings are affected by our inner drive to succeed over life's challenges while we set goals for ourselves and for the organizations that we work for and the lives and people that we love. Our motivation also promotes our feelings of competence and self-worth as we achieve our goals; thus, it is a critical component of the Lean management system. It provides us with means to compete with others to better ourselves, and to seek out new information to learn and absorb, and to leapfrog the competition; or to better collaborate, if that is the goal. Individuals experience motivation in different ways, whether it is task oriented or ego-based in nature.

Some strive to achieve their goals for personal satisfaction and self-improvement whereas others compete with their surroundings in achievement settings to simply be classified as the best. Motivation and the resulting behavior are both affected by the many different models of achievement motivation and organization diagnostics. These models, although separate, are very similar in nature and theory. The mastery and

performance achievement settings each have a considerable effect on how an individual is motivated.

Although we seem to favor some in this chapter, each theorist has made a contribution to the existing models and theories in today's achievement studies. More often than not, theorists build off of each other's work to expand old ideas and create new ones and we have done the same in this book. Achievement motivation is an intriguing field, and we find that the experts are more interested after reviewing similar theories from different perspectives.

REFERENCES

1. A. Elliot and J. Harackiewicz, "Approach and avoidance achievement goals and intrinsic motivation: A mediational analysis," *Journal of Personality and Social Psychology*, 51, 1058–1068, 1996.
2. A.J. Elliot and H.A. McGregor, "Test anxiety and the hierarchical model of approach and avoidance achievement motivation," *Journal of Personality and Social Psychology*, 76, 628–644, 1999.

6

Lean Educational System

> One's mind, once stretched by a new idea, never regains to its original dimension.
>
> **Oliver Wendell Holmes**

IN A NUTSHELL

Education in industry has long been a challenge. In this chapter, we discuss the education component of the education, application, communication model presented in Chapter 4. New learning of Lean concepts and tools is the first step in continuous improvement activities.

Completing a transformation to a Lean management system requires commitment and time focused on employee education at all levels of the organization. While in a rush for short term profits, these are resources that many organizations are unwilling to invest. Organizations can sometimes behave like little kids that are sick and do not want to take their medicine. And like little kids they complain … the common replies by management to Lean implementation projects that do not achieve management objectives are too little time for employee education and too little time for the implementation process. These types of common replies indicate the true view that traditional management has for Lean initiatives or Lean management. They are more of an afterthought than the core business operational philosophy that they should be.

In academia today, U.S. colleges and universities typically offer Lean management as online certificates or continuing education courses. Rarely, if ever, is Lean at the forefront of serious business schools and

given the respect or prominence it has demonstrated it deserves as a superior organizational management philosophy. It is usually buried in courses regulated to manufacturing and engineering curricula. And as a nation, we are often confused as to why American organizations cannot compete in the global marketplace. Do not get the authors wrong, engineering and manufacturing need Lean; but more importantly, Lean management as the dominant business management approach would position American organizations to achieve the world class status they covet.

As increased competition, limited resources, and a tight economy force business to become leaner and more agile, the organization's education system of Lean techniques teaches learners, workers, and managers how to increase effectiveness and efficiency, decrease waste, and achieve the highest quality. The system of education offers both an overview of Lean techniques to be used as a general introduction to Lean practices, along with Lean techniques, and online learning modules for in-depth study of Lean practices. The focus is to provide Lean training to empower learners to identify and eliminate wasteful organization-wide practices.

OVERVIEW

What is an educational system? Does your organization currently have one? Whether defined or not, or openly visible, all organizations have an in-process educational system. It is human nature to learn from our surroundings, peers, and management. The fact is that *Employees are always learning in your organization*. The real question becomes, what are they learning? Are they learning traditional beliefs or Lean beliefs? Are they tangled up in a web of behavior waste that dominates your current social system? Are they learning non-Lean behaviors from the management, peers, and subordinates? In the absence of sustained Lean learning effort, employees learn how they live in the organization on a daily basis. They then project this learning throughout the organization. Unfortunately, most of what they learn is wasteful behavior that undermines productivity and company profitability.

This is why all organizations developing a Lean management system need a well-defined educational system. The foundation of a

Lean management system is defined by the learning environment and employee educational process present in your organization. This is a continuous effort that requires the development of a new philosophical approach by managers and a new understanding of the concept of *management* in a Lean organization. Moreover, the organization must first realize and embrace the fact that the Lean educational process is for everyone.

LEAN IS FOR EVERYONE

Although Lean was developed for the manufacturing community, in recent years, it has become a vital tool for process improvement in virtually all organizations. All companies expecting to compete and grow in the global marketplace, be it for products or services, need to be involved in continuous improvement programs. One thing is for certain, Lean management is here to stay. Those companies that adopt Lean management will prosper and those that do not will stagnate and eventually be driven from the marketplace.

Lean is not only for every company but also for every employee of every company. Even the behemoths of bureaucratic red tape-like government agencies and the health-care industry are adopting a Lean management philosophy. Lean concepts are currently being universally accepted and applied in virtually every type of organization. These include service industries, such as health care (emergency rooms, doctor's and dentist's offices); restaurants; city, county, state, and federal government agencies; the armed forces (Army, Navy, and Air Force); and nonprofit organizations. Regardless of what you do, there is a process involved and Lean management can help your organization improve its performance. Lean is truly for everyone.

Lean is not only for every manufacturer, but also for federal, state, or local government agency and nonprofit, health-care, or service industry. As previously discussed, Lean is the process of identifying and eliminating waste throughout your organization. The end goal is to improve the value-added process. The Lean practitioner is always trying to make the complex simple, eliminate waste, and add value from the customer standpoint. Lean has been described as an organizational philosophy and collection of process improvement tools that can be either qualitative or quantitative in nature. Most of the qualitative

aspects of the tools have to do with (1) how your organization thinks, believes, and behaves and (2) how your organization physically looks. Workplace Organization and Standardization using visual controls systems that show you at a glance "what needs to be completed next"; and Kanban or supermarket systems are examples of the physical tools. These tools focus on improvement or activities that often happen between process steps, although not exclusively.

Conversely, the quantitative Lean concepts and tools are things that are conducive to direct measurement and can occur between process steps or during process steps. These are things such as cycle time, takt time, and lead time; or productivity measures such as units produced or order processed in a specific time. They can also be concepts and tools that stop defects from occurring, such as quality at the source or Poka Yoke, commonly referred to as mistake proofing. These quantitative tools can be used to improve the manufacture of any product or the delivery of any service.

In many companies, management will tend to focus only on the quantitative tools. No matter how good an organization is at the quantitative tools, it is dedication to the cultural development of the Lean philosophy including qualitative beliefs and behaviors that will dictate the level of success that your organization will achieve.

PURPOSE OF A LEAN EDUCATIONAL SYSTEM

The purpose of the educational system is to educate all employees on a Lean management and operational philosophy along with Lean tools and techniques. There are several fundamental characteristics that should be considered when developing your Lean educational system. These include the following:

- Align the educational system with the organizations mission, vision, and values to serve the customer first.
- Assure that every employee has access to the same Lean thought processes.
- Create a *fear free* learning atmosphere among all employees, which promotes experimentation with opportunities for improvement.

- Encourage employees to challenge current beliefs, policies, practices, and procedures in an effort to improve product or service delivery for customers.
- Create an environment that promotes the use of all employee skills and encourage employee creativity and innovation in their sphere of influence.

The remainder of this chapter is designed to provide the fundamental components to create a Lean educational system.

Lean Education System Starts with Management

What do we mean by management? First, we must say that the authors are not making a personal indictment of management per se that would be C-level, executive management, vice presidents, directors, division management, or department management. Rather, we use the word *management* to expose the non-Lean waste that flows from a traditional management philosophy, organization structure, and operational philosophy. Consequently, if we are to begin the journey toward a truly Lean management system, we need to present an operational definition of what is meant by the word management that is frequently used throughout this book for comparing traditional and Lean organizations.

Definition: "Management" refers to any employee or group of employees that influences in any way the behavior of any other employee or group of employees.

In the truest sense of this word, everyone in the organization is management. In a pure Lean environment, everyone participates in process improvement or Kaizen and by default everyone is a manager of your organization's value-added process. This encompasses the entire organization, and is a radical change from a traditional organization where the belief is that employees are stratified with specific people identified as management. In traditional organizations, sometimes the words of one department or anyone in that department can unduly influence employee behavior in other departments. Some examples are information technology, purchasing, finance, and engineering, to name a few. In this environment, organizations loose contact with their primary objective, that is, to serve the customer. Barriers go up between departments, employees, and management, and consequently, turf wars and fiefdoms develop.

RULES OF TRANSITION:

MANAGEMENT DELEGATES VERSUS MANAGERS SUPPORT

Traditional organizations: Management delegates take up responsibility for actions and initiatives. Many times, this responsibility comes without the requisite authority to effectively complete the initiative.

Lean organizations: Managers support employee actions by providing tools necessary for effective project completion. In addition, they work to remove obstacles and impediments that are restricting employee effectiveness.

In a Lean management environment, all staff at all levels must begin to learn and live a Lean operational philosophy and become Lean practitioners. This is the fundamental challenge in the educational process. How do we create this type of organization-wide learning environment that produces Lean practitioners at all levels of the organization? The remainder of this chapter and book describes a plan for conveying that Lean is for everyone.

LEAN EDUCATION STRATEGY

Senior management's recognition that the organization must "change to improve" is a critical first step to creating a comprehensive Lean educational strategy. The strategy should include a plan for implementation across the organization. During the educational process, it is essential that senior management participate in and learn exactly what the employees are learning, and at the same time that the employees are learning lean. This is required for senior management and all employees to begin to develop new communication ability based on new Lean learning.

If senior management does not participate fully, several unwanted results will occur and the Lean management system will not produce the results commonly reported in effective Lean initiatives. For example, if employees begin learning new Lean beliefs, they will try to implement solutions and then become stifled by management that has not learned

RULES OF TRANSITION:

STATUS QUO VERSUS CHANGE TO IMPROVE

Traditional organizations: A status quo approach basically keeps the company in a holding pattern. Management itself can get caught in the *fear of failure* trap as it struggles to meet shareholder expectations. There is little risk or experimentation in the status quo environment; only the desperate attempt to maintain current performance. In the end, the status quo philosophy is doomed to failure.

Lean organizations: Managers recognize that they need to continuously change to improve organizational performance. They embrace change on a daily basis and encourage all their employees to participate in "Change + Improve" activities.

these new Lean beliefs and tools; the Lean transformation will fail before it has a chance to catch on. Management must be able to quickly pick up and adopt Lean and apply what they have learned while developing a plan for 100% employee participation. Without 100% employee participation, your Lean management system will not be effective!

The new strategy should include revising the mission, vision, and value statements of the organization.

Mission statement: The organizational mission statement should be revised to include several Lean components. These are living a Lean operational management philosophy, fostering an open Lean-learning environment, and fostering an environment for using creativity and innovation during improvement activities.

Vision statement: The organizational vision statement should be revised to demonstrate that the organization strives for 100% employee participation by taking actions to move the company toward a learning and teaching environment. The vision statement should also state clearly the desire to be customer focused, flexible to changes in customer demand, and employee driven.

Values statement: The organization should create a value statement that defines Lean values as presented in the social system for all employees. These values must be integrated into every employee's belief systems.

About Learning Management Systems

The growing shortage of critical skills and labor requires client organizations to increase workforce productivity to drive business performance. To stay competitive, organizations must develop a learning strategy that enables them to develop their asset banks of organizational talent. The lean learning management system (LLMS) manages the delivery of self-paced, blended/e-learning and courses. The LLMS lets you publish courses and place them in an online catalog. Learners log into the LLMS using a browser, select courses from the catalog, and launch them. The LLMS tracks the learners' activities with the courses. The LMS provides online reports for each course and learner.*

A learning content management system is a related technology to the LLMS (e.g., WebCT) in that it is focused on the development, management, and publishing of the content that will typically be delivered via an LLMS. The core online LLMS empowers any enterprise, organization, school, or business with the ability to manage and run their own online university or e-learning portal. The advanced application enables organizations to deliver customized courses, videos, live seminars, and tests via the Internet. LLMS designs provide for a scalable system that encompasses a total and complete foundation for all aspects of e-learning.†

With a well-designed LLMS, you can assess, plan, deliver, manage, and improve both self-paced and instructor-led training processes. And there are some free and complete, secure, web-based training and e-learning solutions that employ a simple and intuitive user interface.

* LLMSs range from systems for managing training and educational records to software for distributing courses over the Internet with features for online collaboration. Corporate training uses LLMS to automate record-keeping and employee registration. Student self-service (e.g., self-registration on instructor-led training), training workflow (e.g., user notification, manager approval, and wait-list management), the provision of online learning (e.g., computer-based training, read and understand), online assessment, management of CPE, collaborative learning (e.g., application sharing and discussion threads), and training resource management (e.g., instructors, facilities, and equipment) are dimensions to LLMSs.

† Some LLMS are web-based to facilitate access to learning content and administration. LMSs are used by regulated industries (e.g., financial services and biopharma) for compliance training. It is also used by educational institutions to enhance and support classroom teaching and offer courses to a larger population of learners across the globe. Some LLMS providers include *performance management systems* that encompass employee appraisals, competency management, skills-gap analysis, succession planning, and multirater assessments (i.e., 360° reviews). For the commercial market, some learning and performance management systems include recruitment and reward functionality.

By utilizing a blended approach of custom and free offerings, both technical and nontechnical training managers can easily create, manage, and track interactive training courses and learning programs for all levels of users.

An LLMS is an integrated software package for delivering, tracking, and managing training. LLMSs range from systems for managing training records to software for distributing courses over the Internet and offering features for online collaboration. In many instances, corporate training departments purchase LLMSs to automate record-keeping as well as for the registration of employees for classroom and online courses. Student self-service (e.g., self-registration on instructor-led training), training workflow (e.g., user notification, manager approval, and wait-list management), the provision of online learning (e.g., computer-based training, read and understand), online assessment, management of continuous professional education (CPE), collaborative learning (e.g., application sharing and discussion threads), and training resource management (e.g., instructors, facilities, and equipment) are dimensions to LLMSs.

Most LLMSs are web-based to facilitate access to learning content and administration. LLMSs are used by regulated industries for compliance training. Some LLMS providers include *performance management systems* that encompass employee appraisals, competency management, skills-gap analysis, succession planning, and multirater assessments (i.e., 360° reviews). For the commercial market, some learning and performance management systems include recruitment and reward functionality. The software is used to deliver personalized learning and training to the entire organization. Whether you are a global enterprise or local operation, you can leverage the power, simplicity, and scalability of the COTS (commercial-off-the-shelf) software to connect clients with customers, partners, employees, or students in a seamless self-service, on-demand e-learning system. Knowledge and learning can now be delivered instantly to everyone, anywhere in the client organization.

Although an LLMS for corporate learning, for example, may share many characteristics with an LLMS, or virtual learning environment, used by educational institutions, they each meet unique needs. The virtual learning environment used by universities and colleges allows instructors to manage their courses and exchange information with students for

a course that in most cases will last several weeks and will meet several times during those weeks. In the corporate setting, a course may be much shorter, completed in single instructor-led or online session.

Lean Management Education Description

The following components are usually part of the Lean management education system: Lean education content delivery and implementation options vary by content type—library or custom—and whether or not the client chooses to deliver the content via an LLMS or to host in a provider's learning system. To enable institutions to leverage their investments in LLMSs, the authors have completed integration with a variety of LLMSs, including Blackboard, WebCT, ANGEL, Gemba Academy, Lean Techniques Suite, GeoLearning, Plateau, and SumTotal.

LEAN EDUCATIONAL SYSTEM: LEAN LEARNING CYCLE™

As discussed in the section on "About Learning Management Systems," your organization must define and manage the educational system and the learning environment. There are a wealth of possibilities for creating and administering the Lean educational system. This section addresses the fundamental components required to achieve a Lean learning environment in your organization.

The primary objective of developing an educational system is to create an active Lean learning and mentoring environment in the organization. An environment where there is constant learning and mentoring going on between all employees at different levels of Lean learning. This is accomplished by conducting a variety of Lean learning activities, Lean improvement projects, and learning to live Lean on a daily basis.

Lean Learning Activities

Lean learning activities should be active across the entire organization. The objective of a Lean management system is 100% employee participation. Consequently, 100% of employees should be active in Lean

learning as an individual, lean team member, or in process troubleshooting. Lean educational systems can contain a variety of approaches to achieve this 100% employee participation. Those organizations that develop and deploy a systematic approach achieve the best performance results. The following sections briefly describe components of a Lean educational system. These should be used as a foundation for your educational system.

Lean University

One approach is to create a Lean university that schedules, administers, and promotes Lean learning across the organization. The university could offer Lean learning on a variety of topics and issue certificates for all Lean concepts, tools, projects, and management philosophy completed. These are taught by internal Lean experts in the form of 1-hour, 2-hour, half-day, full-day workshops, and multiday learning or Kaizen programs. Certificates could also be developed for Lean project management achievements, Lean teams achievements, and Lean troubleshooting improvements.

Employee Road Maps and Cross Training

A Lean educational road map should be developed for the organization; one matrix that contains all available Lean learning activities and a near-term schedule for 100% employee participation in some of these learning sessions. A comprehensive road map is essential for developing the necessary overlap to create continuous flow along the value stream. This road map is developed and deployed as part of the tactical plan to achieve strategic objectives.

Education Deployment (Hoshin Kanri)

Hoshin Kanri is often described as a set of rules or forms used for policy deployment. By definition:

Hoshin = course, plan, or policy
Kanri = management, control, administration, or care for

Similar with many Lean deployments that focus only on tools and not philosophy, Hoshin Kanri is very often misused. It is also much more than tools, forms, or rules. It is a complete philosophy of management. True Hoshin Kanri is about creating a structure for the free flowing transfer of knowledge between employees regarding Lean philosophy and principles.

The idea with Hoshin Kanri is to instill a Lean management philosophy and deploy a standardized or systematic approach known, recognized, and understood by all employees to the extent that they can either work individually or collectively to pursue the mission and vision of the organization. We recommend a comprehensive Hoshin Kanri approach for deploying the Lean education system.

A Hoshin Kanri approach requires that we include a complete process cycle (Lean Learning Cycle) that is built for continuous improvement. As we often say in the process improvement community, you have to understand it to measure it, measure it to control it, and control it to improve it. The education process is no different than any other process in your organization. Our proposed Lean educational system administered through a Lean university has five key components described as the *Lean Learning Cycle*™:*

1. Lean education system definition
2. Knowledge content development and deployment (i.e., knowledge transfer)
3. Knowledge application to the organization
4. Knowledge sharing within the organization and across industry
5. Grading *Learning-Application-Sharing* effectiveness

Lean Educational System Definition

Defining the Lean educational system is a requirement. First, this will vary from organization to organization; however, some form of the Lean educational system—Lean Learning Cycle—presented here must be defined and fully implemented to achieve a Lean management system and ultimately a Lean organization. Once the system is defined and Lean learning is in process, the educational system becomes a living process that, like any other process in your organization, must constantly be

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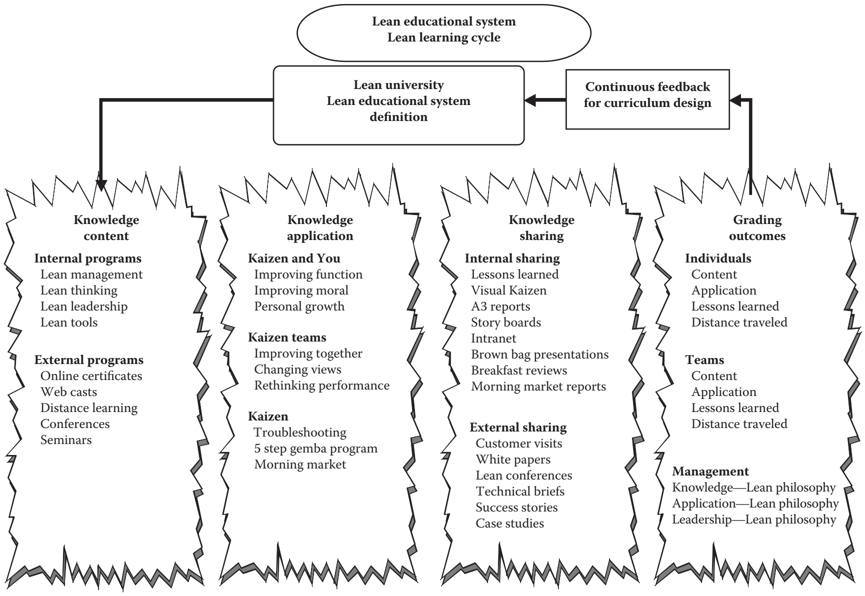
reviewed, enhanced, and improved. The Lean Learning Cycle builds in this feedback and improvement loop.

The basic Lean educational system definition requires four pillars that include the following:

- *Topic selection:* Identify initial concepts to be offered across the organization. These should include Lean philosophy, Kaizen concepts, learning to see waste, learning to measure, and learning to eliminate waste. These topics are presented in detail in Chapters 8 through 11.
- *Course objectives:* The objectives of each class should be stated and employee-students are entitled to know what the learning expectations are. The whole course should be in place before learning begins. The objectives should specify the performance measurement method that can be used by students and teachers.
- *Course content:* The main objective of your Lean university is to have students achieve the full understanding and application of the course content. Since we are dealing mostly with adult education, the courses should be constructed for adult-learning effectiveness. All students cannot be expected to master the courses at the same rate, both personalized lessons and learn at your own pace must be considered and offered in some form to effectively deliver value to students.
- *Course delivery:* A matrix of course offerings could include traditional classroom lecture learning, video, CD, Kaizen events, and so on. Some materials needed for these courses can be purchased off the shelf for delivery by Lean mentors; others need to be developed internally. The courses offered should be in place before students enroll, with the Lean mentor responsible for each course. Since smaller amounts of material are more digestible than larger amounts and adult students learn better if they are given frequent and immediate rewards, a number of programs described below are half day or fewer programs.

The content should be self-contained and students should be able to repeat these courses as necessary without trouble, so students can practice. Content can be presented as class exercises, sample work projects, workshops with multiple concepts, group discussion analysis, postmortem projects analysis, and problem solving.



Knowledge Content Development and Transfer

Lean *knowledge transfer* is accomplished through a series of internal and external programs. These are prepared and delivered by Lean mentors. A sample of the concepts needed in these programs is presented as follows:

- Internal programs
- Lean management philosophy
- Lean thinking
- Lean leadership
- Lean tools
- External programs
- Online certificates
- Web casts
- Distance learning
- Conferences
- Seminars

Knowledge Application (Kaizen)

Kaizen is both the lifeblood and the inspiration for employees to participate in your Lean management system. It is the single most important instrument used to transform your company into a Lean organization by

effectively engaging all employees in the change + improve environment. Kaizen is discussed in detail in Chapter 10. Three key concepts of Kaizen are presented here as vital parts of the Lean education system.

Kaizen and You

Every single employee in the organization should have a personal Kaizen action plan. This improvement plan is focused around their specific area of function and defines their personal ongoing improvement activities. It includes daily improvement learning, individual activities, and team or process troubleshooting activities that they are participating in. At any point in time, each employee's Kaizen activities should be visible to other employees or visitors.

Kaizen and Teams

In addition to the individual Kaizen action plan, Kaizen teams are a critical component of a Lean management system. They function on improvements that are larger in scope and cannot be solved with Kaizen and You activities. Typically, they encompass cross-functional teams of employees from across different functional areas. Kaizen teams are necessary to help tear down interdepartment barriers that are common in vertically integrated companies (basically all traditional organizations) and which impede delivering value for the customer, which must run horizontally across your company from customer request for product or service to your delivery of that product or service.

A number of Kaizen teams across the company should be working on specific projects focused to achieve overall company improvement of strategic or tactical measures. Developing an effective measurement system is discussed in detail in Chapter 8.

Kaizen and Process Troubleshooting

Kaizen in process troubleshooting is a vital educational tool to address issues that commonly arise on a daily basis. A number of employees across the organization need to become experts in process troubleshooting techniques. Tools such as the "5 steps of process troubleshooting" and "morning market" are common place in a Lean management system and must be part of the ongoing employee educational process. Both these topics are covered in detail in Chapter 10.

Knowledge Sharing

Lean *knowledge sharing* is critical to the successful deployment of a Lean management system. Virtually, every text written on Lean implementation discusses the fundamental need for sharing knowledge among employees at all levels of the organization. One of the common attributes of Kaizen is that it is contagious. Once the sharing hits a critical mass in the organization, it becomes engrained in the beliefs and becomes part of the daily living in the organization. This is the ultimate objective of knowledge sharing to create a perpetual improvement and learning environment. A number of internal and external sharing instruments are presented here:

- Internal sharing
- Lessons learned
- Visual Kaizen
- A3 reports
- Story boards
- Intranet
- Brown bag presentations
- Breakfast reviews
- Morning market reports
- External sharing
- Customer visits
- White papers
- Lean conferences
- Technical briefs
- Success stories
- Case studies

Grading Outcomes

As with all learning or improvement programs, we must measure what we have learned. The question is how? With most Lean learning there are assignments or exercises that can be readily assessed. Much of this should be done simply on a pass/fail basis. The point here is for the student to always learn and be successful. There should be no punishment for difficulty learning, only positive reinforcement when Lean learning is achieved. Those employees who learn at slower rates need to be afforded

the opportunity to retake courses, learn at their own pace, whatever it takes for them to succeed.

A variety of assessments of learning can include traditional tests or quizzes on topics covered in class room lectures, certificates of completion, and so on. In any event, Lean learning must be recognized at the point where Lean concepts are successfully applied in the workplace. This is critical at all levels including the senior management level. The grading system should address Lean learning at three levels:

Individuals
- Content
- Application
- Lessons learned
- Distance traveled

Teams
- Content
- Application
- Lessons learned
- Distance traveled

Management
- Knowledge—Lean philosophy
- Application—Lean philosophy
- Leadership—Lean philosophy

KEY EDUCATION SYSTEM IMPLEMENTATION CHALLENGES

Although there are numerous reasons cited in the literature why Lean initiatives can fail, these are predominantly regarded as symptoms and not as root causes. Some of these are industry-specific obstacles identified as reasons for discarding Lean initiatives or used to support the position that Lean "doesn't work" in our industry. All of these *lower level* reasons can be rolled up to three fundamental root causes of Lean failures.

As we have discussed in the technical system, social system, and here in the education system, there are a few dominant root causes for the relative success or failure of Lean management systems. All three of these can also

be traced to the education system. The three fundamental challenges that senior managers must face and overcome to implement an effective Lean educational system are as follows:

1. Supporting and promoting the time and resource commitment to Lean education.
2. Discarding *old beliefs* and installing *Lean beliefs*.
3. Adopting Lean management philosophy and converting to a *Learning organization*.

Time and Resource Commitment

The sustained commitment to a Lean education process is imperative to developing a Lean management system. Employees need time to absorb Lean concepts, try storm solutions, and begin to live Kaizen. A traditional manager's view of the time as solely there for consumption on *production* activities has to be eliminated. The Lean view of time as an *educational* commodity that will give back improvement dollars that are many times (e.g., 3–10 for every dollar invested) more than the time investment in process improvement is a *new belief* that must be adopted before managers will fully embrace Lean education as a profit center rather than as an expense.

According to the American Society for Training and Development (ASTD), expenditures as percentage of payroll for *best* organizations in the survey were approximately 2.2%, and 43 hours per employee per year.* These are direct training hours. Lean education also includes time-on-task and improvement activities. Lean organizations can anticipate investing up to 10% employee time on comprehensive improvement activities.

Discarding Old Beliefs

The challenge of leaving behind old beliefs is significant for individuals and organizations alike. The inability to release old beliefs causes learning issues and diminishes the effective adoption of a Lean education system. As discussed in detail in Chapter 5, our beliefs are fundamental drivers of our day-to-day behavior. Significant effort and emphasis will have to be paid to transitioning from old beliefs.

* ASTD Benchmarking Forum Survey 2005.

Transitioning to a Learning Organization

Loosening the command and control structure in favor of a learning environment is very difficult for most organizations. It requires time to be absorbed by senior managers and department managers alike. Relinquishing improvement initiation to subordinates and allowing Kaizen to flourish, a requirement for the creation of a learning environment is often more than traditional managers can accept. However, they must learn to embrace this environment for Lean education to be successful.

SUMMARY

A comprehensive Lean educational system is the foundation of an effective Lean management system. Lean education should target 100% employee participation and have a plan for employee participation. Everyone in the organization should be aware that Lean is for everyone and promote lean across the company.

As a first step to a comprehensive Lean management system, senior managers must commit to Lean, and establish and deploy a Lean educational strategy. This encompasses setting up the infrastructure to deploy a Lean Learning Cycle structured for continuous operation and improvement. The outcome of the Lean Learning Cycle is the creation of a *learning organization*. One where employees are encouraged to look for opportunities for improvement and use the Lean tools to develop and implement creative and innovative solutions for the challenges faced in their respective functions. A learning "Try Storming" environment is present in all successful Lean management systems, and will begin to appear soon after commitment to the Lean Learning Cycle.

7

Waste Identification

> There is nothing so useless as doing efficiently that which should not be done at all.
>
> **Peter F. Drucker**

IN A NUTSHELL

Waste is generally composed of unnecessary activities that can be described either qualitatively or quantitatively. In its most basic form, Lean Six Sigma (LSS) encompasses both these descriptors. Waste identification is also called learning to see muda, which is a traditional Japanese term for an activity that is wasteful and does not add value or is unproductive, value-none, trivial, or unuseful.* It is also one of the three key concepts in the Toyota Production System (TPS). The other two are mura, which means irregularity, unevenness, or variability, and muri, which refers to overburden or strenuous work.[1] These three terms describe the waste that infiltrates organizations and allows us to begin *learning to see* waste.

Waste identification and reduction is an effective way to increase profitability. Toyota merely picked up these three words beginning with the prefix *mu-*, which in Japan are widely recognized as a reference to a product improvement program or campaign.

In this chapter, we present fundamentals on how to recognize muda, mura, and muri in the workplace. The chapter discusses the importance of looking at your organization in new ways, developing an inquisitive approach that encourages questioning of current beliefs and practices,

* Muda, 無駄; translation to English on Sanseido: *exceed. Japanese-English Dictionary.*

and taking a look at everything you do from the customer viewpoint. One approach is to start at the end; that is, walk backward through your organization assessing process steps in reverse and asking questions. To this end, we include a series of checklists to get the LSS practitioner thinking in new ways.

OVERVIEW

Until recently, when we talk about learning to see waste, we are considering organizational wastes, not behavioral wastes. However, behavioral wastes can severely hinder Lean initiatives. This chapter describes what waste is and how to identify waste. It also discusses the mindsets that are the root causes of waste. These mindsets or belief systems are put into context here and described with terms like *just-in-case logic*. Almost all organizational wastes or process wastes are related to an employee in the organization that holds a traditional belief system.

Learning to see variation (mura) or waste (muda) requires a shift in how we view our organization. How do we view our processes? How do we measure our processes? What questions we ask about process performance, people performance, and equipment performance all indicate how we look at variation and waste. Throughout this chapter we present checklists that help you to begin to question everything you do in an effort to learn to see variation and waste in a new light.

WHAT IS VARIATION?

The way in which numbers differ is called variation.[2] Virtually everything that is measured is subject to variation. Our equipment is subject to variation. Our employees are subject to variation. The instrumentation that we often use to measure a process is subject to variation. How we measure our measures can be a key source of variation. There is variability inherent in many methods completed in our value-adding processes. For example, one of the most critical and prevalent tools used in every organization today is the computer and its software packages. How we gather information, analyze information, and report information can be subject

to tremendous variation. On the basis of the simple observations, one can see why the study and understanding of variation is a critical component to an LSS organization.

Variation can also be described as "a measure of the changes in the output from the process over a period."[3] As you collect data over time, you can measure and view the variation of process input variables, process methods, or process output variables. Understanding, controlling, and limiting process variation is a primary goal of any LSS practitioner. As we begin our journey toward being an LSS organization, we must become proficient at measuring variation, analyzing root causes of this variation, and taking corrective actions to eliminate variation from all of our processes.

The entire study of variation is an endeavor to quantify and chart process behavior. At the beginning of our value-added (VA) processes, we can quantify and chart our process input variables. These include the 5Ms: materials, machines, manpower, methods, and measurements. The objective here is to minimize variation in our supply chain inputs to our VA processes. For example, by measuring variation in material specifications, we are able to better control our value-adding process steps, thereby assuring a predictable outcome for product performance.

How Do We Chart Variation?

One of the most common process output variables in an LSS environment is process lead time. In many instances, customers are sensitive to the amount of time it takes us to add value for them. How we organize our materials, deploy our human resources, set up our equipment, and sequence our VA steps has a tremendous influence on our process output lead time. The average lead time chart in Figure 7.1 shows how the lead time varies over time, specifically, how month-to-month lead time varies during the year. It also shows the upper control limit and lower control limit for the data set.

Why Is Understanding and Controlling Variation So Important?

Simple charting like this can help us to understand, control, and improve lead time for our customers. The importance of understanding, charting, and controlling process variation cannot be overstated. Understanding variation and decreasing variation is the fundamental underlying foundation of all LSS organizations. First, it allows us to understand, control,

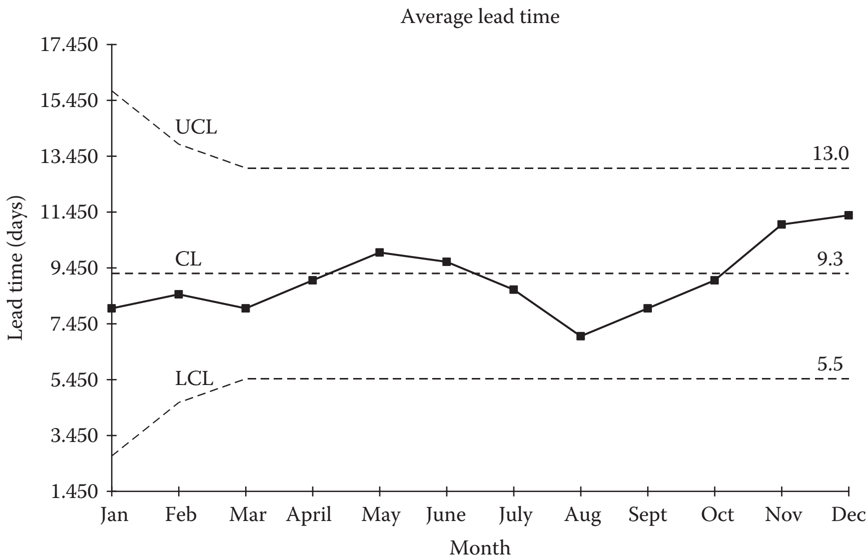


FIGURE 7.1
Average lead time chart.

and improve our entire supply chain, which includes many activities that are conducted outside of our physical facilities. Second, it allows us to uncover valuable insight concerning the interactions between materials and our processing equipment. Perhaps, more importantly, it provides a fundamental foundation for assessing our performance output behavior that is critical for customer satisfaction. Virtually all of our outputs are key performance indicators and subject to variation. As a consequence, our ability to understand and chart variation is paramount for improved performance from a customer viewpoint. The remainder of this chapter and several chapters that follow in this handbook are dedicated to understanding waste identification and process variation, and applying LSS tools for process improvement.

WHAT IS WASTE?

Describing waste is not as easy as one might think. Waste appears throughout organizations and is often mixed with nonwaste. There are times and conditions within our organizations where deciding what is

waste versus nonwaste can be somewhat of a moving target. For example, in today's organization, e-mail is virtually impossible to live without as a communication tool. In and of itself, it has great capacity to assist with many processes. Yet it can also be a significant source of extra processing waste. The telephone can produce a similar waste, but are all telephone calls wasteful? There are times when some organizations consider inventory an asset, that is, right up until the customer no longer wants to purchase the inventory. Clearly, one or more definitions describing just what is waste (all nonvalue-added [NVA] activities) and what is not waste (VA activities) are needed.

Defining the Value-Added Work Components

LSS organizations are constantly searching for more effective ways to deliver value for the customer. How do we define value and distinguish it from activities that produce no value?

To better understand this term, we have provided you with a practical definition of VA, NVA, and NVA but necessary (see Figure 7.2). VA is an activity that transforms or shapes raw material or information to meet customer requirements.

Organizations that strive to eliminate NVA work while increasing their VA work are the ones that will be the most successful.* There are a number of ways to accomplish this. One of the most effective

- <u>Value-Added</u> is an activity that transforms or shapes raw material or information to meet customer requirements.
- <u>No-Value-Added</u> is an activity that takes time, resources, or space, but does not add to the value of the product or service itself from the customer perspective.
- <u>No-Value-Added but Necessary</u> is an activity that does not add value to the product or service but is required (e.g., accounting, health and safety, governmental regulations, etc.). In the Business Process Management methodology this is called "business value added."

FIGURE 7.2
Definitions of VA, NVA, and NVA but necessary.

* As a management technique, companies seek to provide additional VA in their products as a way of distinguishing them from competitors; VA in this sense is a means of avoiding commoditization and maintaining profit margins.

ways is to first evaluate the practices used, so you can recognize any NVA work and then take steps to reduce it and be more efficient in your work. The basic characteristics include VA components, such as customer VA and operational VA, as well as NVA components such as idle time, rework, and bureaucracy. Detailed analysis of these factors is a fundamental part of waste identification and the foundation of LSS initiatives.

In the case of a manufacturing operation, VA means all those activities that turn raw materials into value (the product) for your customer. In the case of a service organization, VVA means all those activities that are required to deliver the intended service. In essence, the service is your product. Your VA product or service is what you end up with, or what the customer wanted. Conversely, NVA is anything that the customer in not willing to pay for. NVA entities can be employee activities, materials, information exchanges, and equipment. The difficulty comes in separating NVA from VA activities and still providing what the customer wanted. The remainder of this section is about identifying anything that is NVA in your organization.*

HOW DOES WASTE CREEP INTO A PROCESS?

Waste can creep into any process over time and usually does.† In the 1980s there was a popular story about a tire manufacturing plant in the Midwest. The story goes that they were conducting a continuous improvement effort when one of the observers posed a simple question

* Many of the TPS/Lean techniques work in a similar way. By planning to reduce manpower, or reduce changeover times, or reduce campaign lengths, or reduce lot sizes, the question of waste comes immediately into focus upon those elements that prevent the plan being implemented. Often it is in the operations area rather than the process area that muda can be eliminated and remove the blockage to the plan. Tools of many types and methodologies can then be employed on these wastes to reduce or eliminate them.

† Shigeo Shingo divides process-related activity into process and operation. He distinguishes process, the course of material that is transformed into product, from operation, which are the actions performed on the material by workers and machines. This distinction is not generally recognized because most people would view the operations performed on the raw materials of a product by workers and machines as the process by which those raw materials are transformed into the final product. He makes this distinction because value is added to the product by the process but not by most of the operations. He states that whereas many see process and operations in parallel, he sees them at right angles (orthogonal); this throws most of operations into the waste category. See value stream mapping for a further explanation.

to an operator. "Why are we wrapping these tires in protective white plastic?" The operator was not sure; his reply was that they had done it for the 3 years that he had been with the company. So they went to the shift supervisor and posed the same question. His response was that the machine was there since he joined the company 7 years earlier. He said that Charlie in maintenance may know; "He's been here for 25 years." So they headed off to maintenance to find Charlie. When they posed the question to him, he replied that it is to protect the whitewall tires in shipping. They had not made whitewall tires in the plant for years; however, they continued to wrap the newer all-black tires as if they had whitewalls. This is one example where a product change without a process change allows waste to creep in to your process.

POWER OF OBSERVATION

From the Renaissance period in the 1500s to the emergence of many of the pure and applied sciences in the 1700s to 1800s, there were limited technical tools compared to today. There were no computers, no Internet with instant information, no instant communication, no telephone, and no mass transportation. The sharing of knowledge was slow and difficult. In relative isolation, science was advanced by disciplined individuals committed to observation and experimentation.

It was during these times that the power of observation was the dominant tool for improvement. As mechanical scientific instruments were developed, these highly trained and skilled observers applied these tools, coupled with keen observation capabilities, to make astounding discoveries. However, in almost every organization that we go into, the power of observation is almost nonexistent. Employees at all levels wander through the organization focused on their individual worlds and completely ignoring the blatantly obvious signs of waste that engulf their organization.

Some have called these *organizational cataracts*. These cataracts can grow and hinder our vision and render the power of observation an obsolete tool. Managers fail to see the waste of rework associated with the poor scheduling or haste with which they initially produced a product. Employees focused exclusively on a daily production deadline completely miss a multitude of opportunities to improve their environment in favor of producing the daily production quantity.

> The range of what we think and do is limited by what we fail to notice. And, because we fail to notice that we fail to notice, there is little we can do to change until we notice how our failing to notice shapes our thought and deeds.
>
> **R.D. Laing**

This approach (observation and experimentation), which has been used by science for hundreds of years, is the key to advancing knowledge and improving our understanding of our surroundings. We must be able to accurately observe our surroundings, document what we see, investigate and analyze our observations to find out what is causing what we see, and ultimately take effective action to improve our environment.

> Science is "the desire to know causes."
>
> **William Hazlitt (1778–1830), English essayist**

This emergence of the power of observation is a key ingredient in the formation of a learning environment. The remainder of this chapter is about igniting the power of observation in our employees. More importantly, it is about learning to see waste and variation with new eyes, eyes that know what to look for.

SEEING WITH NEW EYES

Traditionally, Lean has classified waste into eight major categories. These categories were developed based on visual symptoms in the organization. We have added a ninth waste, behavior waste, which revolves around individual and collective belief systems and how they influence daily behavior. The remainder of this chapter discusses each category in detail.

What types of waste are present? What are typical causes of each waste? How can waste be identified? Checklists are included to assist you with learning to see waste and variation. However, you are encouraged to expand these checklists by looking at each process step in your organization and developing your own questions. The nine waste categories are the following:

1. Overproduction
2. Excess inventory
3. Defects

4. Extra processing
5. Waiting
6. Motion
7. Transportation
8. Underutilized people
9. Employee behavior

Waste 1: Overproduction

Overproduction means making more of a product than is needed by the next process or the end customer.* It can also be described as making the product earlier in time than is needed or making a product at a faster rate than is needed. Overproduction has been labeled by some as the worst waste because typically it creates many of the other wastes. For example, overproduction leads to excess inventory, which in turn leads to the wastes of motion and transportation. In addition, excess inventory requires more people, equipment, and facility space, all of which reduce company productivity and profitability. This is shown in Figure 7.3.

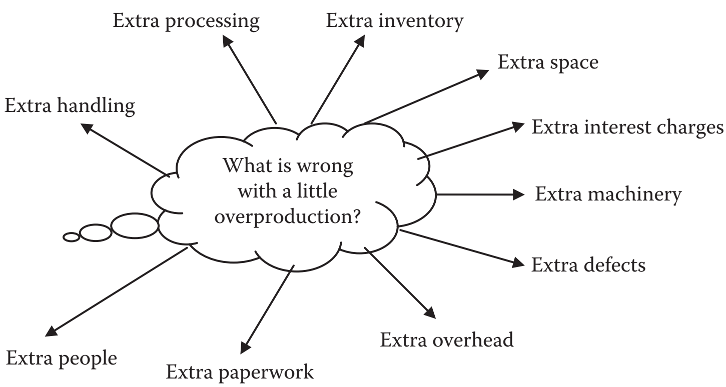


FIGURE 7.3
Waste of overproduction.

* Overproduction happens each time you engage more resources than needed to deliver to your customer. For instance, large batch production, because of long changeover time, exceeds the strict quantity ordered by the customer. For productivity improvement, operators are required to produce more than the customer needs. Extra parts will be stored and not sold. Overproduction is a critical muda because it hides or generates all others, especially inventory. Overproduction increases the amount of space needed for storing raw material as well as finished goods. It also requires a preservation system.

What Causes Overproduction?

Overproduction can be traced to many management and employee behaviors. Some of the most common causes are the following:

- Just-in-case logic
- Unleveled scheduling
- Unbalanced workloads
- Misuse of automation
- Long process setup times

Just-in-Case Logic Trap

Just-in-case logic is exactly what it sounds like. You make more product *just-in-case*—you fill in the blank. For example, just-in-case the machine breaks down, just-in-case our suppliers do not send enough raw materials, just-in-case our customer orders more than we can make or deliver on time, and so on. There are many reasons for using just-in-case logic, and they are all bad!

Just-in-case logic is one of the most common non-Lean employee behaviors present in companies today. It is responsible for productivity losses in any type of organization by robbing employee time while working on NVA overproduction. It is commonly found in other waste categories, such as the waste of motion, transportation, inventory, waiting, and defects. Most importantly, it reveals an inherent weakness in your current process capability and reliability. Managers that practice just-in-case logic invariably have poorly understood processes and poor process control. Instead of fixing the process, they prefer to mask the system with just-in-case overproduction. They have fallen into the just-in-case logic trap. Do not do it!

Unleveled Scheduling and Unbalanced Workloads

Unleveled scheduling and unbalanced workloads can both lead to overproduction. When these conditions occur and employees continue to produce, even when there is no customer demand, overproduction occurs. In forecast-driven environments, unleveled scheduling frequently occurs. In areas where the workload is not balanced properly between two or more process steps, one step will have excess capacity while the next may have excess demand.

Misuse of Automation

Another common mistake is that owners, senior managers, and/or department managers want to see expensive equipment running, not sitting idle. This misuse of automation can cause severe overproduction. Not very often does customer demand exactly meet machine capacity. One of the most difficult challenges for LSS practitioners is to change the misconception that the machine must always be running. In environments where there is a combination of automated and manual production, the misuse of automation at one process step creates the unleveled scheduling and unbalanced workloads at downstream process steps. In this case, we have one cause of overproduction (misuse of automation) forcing overproduction at another process step.

Long Process Setup Times

The length of time required to set up equipment has long been a primary justification for overproducing and carrying excess inventory. The traditional thought is that if your setup times are long, then you must build larger batches than are required. One traditional approach is to define an economic order quantity (EOQ) where the changeover cost + the inventory carrying cost are the lowest, and then you build a batch this size. This concept is shown in Figure 7.4. Do these assumptions on batch size selection make sense if changeover time can be significantly reduced? The

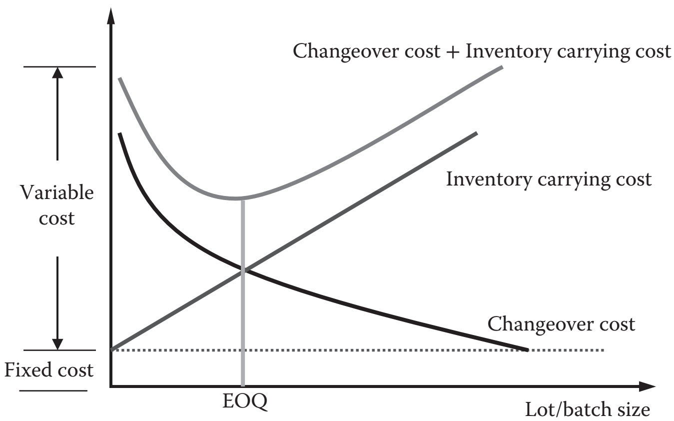


FIGURE 7.4
Batch size selection based on changeover cost and inventory carrying costs.

answer is no. As you reduce changeover time, you reduce both changeover cost and the inventory carrying cost, and the EOQ moves toward the left on the chart. In this case, instead of using EOQ, target your processes to build just what the customer wants. The most cost effective EOQ is always what the customer wanted.

This is a classic example of bad measures driving bad behavior. The primary assumption that you have to live with long changeovers and high inventory levels and inventory carrying costs, rather than try to eliminate them, was made based on these two measures. In an LSS environment we focus on the process (long changeover time), identify the waste, and eliminate the waste by simplifying the setup process.

How to Identify Overproduction

The learning to see overproduction checklist in Figure 7.5 presents several questions designed to help you identify overproduction.

Waste of Overproduction Checklist			
Process:	**Date:**		
Description	**Yes**	**No**	**Apparent Cause**
Do we make more product than is required by the next process step?			
Do we make more product than is required by the customer?			
Do we make product faster than is required and store it for later use?			
Do we keep machinery running even when there is no demand?			
Do we create "busy work" for employees when demand falls?			
Are we producing more reports than needed?			
Are we making extra copies than needed?			
Are we printing, faxing, and e-mailing more than what is needed?			
Are we entering repetitive information on multiple work documents or forms?			
Are we ordering more tests or services than what is required by the customer or patient?			

FIGURE 7.5
Learning to see overproduction checklist.

Waste 2: Excess Inventories

Excess inventory is "any supply in excess of a one-piece flow through your manufacturing process."* One-piece flow is often referred to as a *make one–move one environment*. Excess inventory could also refer to any finished goods inventory. Most organizations today run a mixed model of both *build to order* and *build to stock* products. Although some amount of raw materials and finished goods is required, many organizations use inventory to cover up poor process performance. They keep raising the level of inventory until they cover process problems.

Like all of the nine wastes, living with excess inventory creates the *more syndrome*. For example, in an excess inventory environment, your company requires more people, more equipment, and more facility space. All the while you are making more products (that you may or may not have customers for), more defects, more write-offs, and so on. The *more syndrome* robs your company of productivity and profitability. In an LSS environment we reduce the sea of inventory and use the Lean or Six Sigma tools to identify the root causes of why the inventory was needed and then eliminate the root causes once and for all.

What Causes Excess Inventory?

- Poor market forecast
- Product complexity
- Unleveled scheduling
- Unbalanced workloads
- Unreliable or poor-quality shipments by suppliers
- Misunderstood communications
- Reward system

Poor Market Forecast

Many organizations decide what they will build based on a market forecast. Basically they take a sales and marketing forecast and convert it to a manufacturing forecast and then in turn set up a build schedule. Unfortunately, the only thing we can say about a forecast with a high degree of certainty is that it will be wrong. When this occurs,

* Inventory, be it in the form of raw materials, WIP, or finished goods, represents a capital outlay that has not yet produced an income either by the producer or for the consumer. Any of these three items not being actively processed to add value is waste.

organizations are typically left with large amounts of inventory, much of which may be unsalable.

Product Complexity

In a rush to get to market, many products are moved from the product development to full production before sufficient design for manufacturability has been completed. When product complexity is high, there are several issues that lead to excess inventory. These include raw materials performance issues, engineering changes that lead to supplier changes, production issues, and in-service performance, to name a few. In a competitive product cost environment, product complexity and high quality are often at odds with each other and are another source of excess inventory.

Unleveled Scheduling and Unbalanced Workloads

Similarly with overproduction, unleveled scheduling and unbalanced workloads can both lead to excess inventory. These conditions typically occur in forecast-driven environments. In areas where the workload is not balanced properly between two or more process steps, one step will have excess capacity while the next may have excess demand. In the end, you wind up with excess inventory.

Unreliable or Poor-Quality Shipments by Suppliers

LSS organizations can only be sustained with an LSS supply chain. Inferior materials can, and often do, produce myriad troubles during your VA activities. Unreliable suppliers that deliver materials of poor quality or insufficient quantities only serve to help your competitors. To achieve LSS performance, focus on developing relationships with LSS suppliers.

Misunderstood Communications

Poor communication invariably leads to excess inventory. In the age of information overload, it is staggering how much bad information our employees are using and how much good information is being unused or misused. There are basically three fundamental areas in all organizations (see Figure 7.6). These are product development or service delivery, operations management, and information management. Most companies are good performers in one or two of these categories, but rarely all three. Depending on the nature and structure of the senior management team, more emphasis usually goes to one area. For example, companies with a perceived technology advantage tend to pay more attention to product or

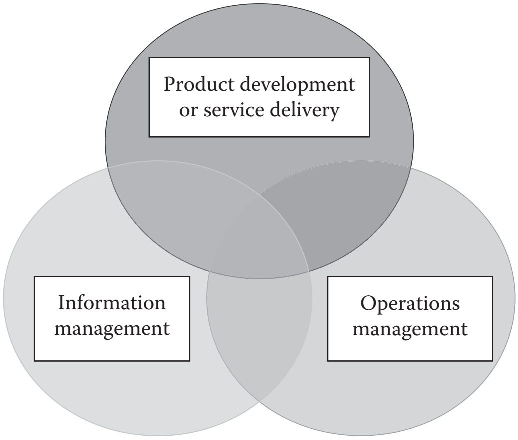


FIGURE 7.6
The organizational universe.

service development at the expense of the other two areas. When communication breakdowns occur, inventory increases, quality decreases, and profitability is hurt. These are signs that you are in a poor communication environment:

- Poorly understood customer requirements
- Product or service is frequently delivered late
- Poor customer satisfaction
- Incomplete or inaccurate documentation
- Poor work instructions
- Inadequate information management system
- Barriers between departments
- Conflicting measurements system

Rewards System

There are several factors of company-wide rewards systems that can contribute to excess inventory. These factors can originate from senior management or from most departments. Because we know that measures drive behavior, poorly defined measures tied to rewards often result in excess inventory and many other wastes.

One example could be if an operations group has a measure of *on-time delivery* without regard for inventory levels. Another may be how the sales group gets compensation. Still another may arise from inadequate knowledge of the true cost of carrying inventory. Regardless of the reasons, if a

large level of inventory exists in your facility, review the rewards program for an inadequate measurements system.

How to Identify Excess Inventory

The learning to see excess inventory checklist presents several questions designed to expose inventory waste (see Figure 7.7).

Waste 3: Defects

Definition

A defect can be described as anything that the customer did not want. Defects include product or service attributes that require manual inspection and repair or rework at any point in the value stream. Defects can be detected and identified before your product or service reaches the customer or post-consumer in the form of warranty returns.*

Waste of Inventory Checklist			
Process:	**Date:**		
Description	**Yes**	**No**	**Apparent Cause**
What does the customer want?			
How much do they want and when?			
What are your purchasing signals; when, how much, how often?			
How do you structure your organization to meet these needs?			
How responsive is your inventory control and purchasing process to fluctuations in customer demand?			
Can you adequately describe the range of your customer demand for products or services?			

FIGURE 7.7
Waste of inventory checklist.

* Whenever defects occur, extra costs are incurred reworking the part, rescheduling production, and so on. Defects cause scrap, repair, rework, backflow, and warranty/replacements; consume resources for inspection, correction, and replacement; cause opportunity loss (capacity and resources used to fix problems); cost 5% of sales for Six Sigma and 40% of sales for One Sigma processes; and reduce variability, lock gains, implement controls, and error proofing.

What Causes Defects?

Defects can result from myriad causes. These causes can be classified into a few basic areas listed below. Each is followed by a brief description.

- Customer needs not understood
- Poor purchasing practices or quality materials
- Inadequate education/training/work instructions
- Poor product design
- Weak process control
- Deficient planned maintenance

Customer Needs Not Understood

Establishing comprehensive customer requirements is essential to defect-free products. More often than not we think we know what the customer wants or we make many assumptions about how he or she will use our product or service or what is important to him or her in terms of product or service performance. The more we can know in this area, the better we can develop our processes to respond to customer requirements.

Poor Purchasing Practices or Quality Materials

In the global marketplace, controlling the supply chain is an ever-increasing challenge. Purchasing departments typically have their own stand-alone measures based on dead materials costs. Material costs are typically very visible in financial statements and a common target for cost reductions. This never-ending pressure for cost reduction frequently pushes product quality below levels expected by customers.

What is *not* present on most financial statements is the cost of quality, which includes repair and rework. Oh, it is present on the bottom line; however, there is no individual expense line item that can be targeted. Many defects can be traced to inferior quality materials. Repair and rework costs for these defective materials increase dramatically further into the value stream your product gets before the defect is discovered. Numbers for how much this costs vary greatly across industries. Some of the components of this cost may include the following:

- Cost of communication with supplier
- Cost of storage until a disposition can be made
- Cost of employee time for physical moves or quarantine

- Cost of employee doing this NVA activity instead of a VA activity
- Cost of repair if required
- Cost of returns to suppliers
- Cost of re-engineering
- Cost of reinspection
- Cost of productivity losses on new products due to staff re-assignment to complete rework

Inadequate Education/Training/Work Instructions

Here is an important rule of thumb: At any given point in time, you should have cross-training capacity at 150% of full production at each process step. To accomplish this, there needs to be a well-defined and executed cross-training program and effective work instructions to carry out the program. Often employees are asked to produce a quality product without adequate education, training, or visual work instructions to complete the task. One of the most effective means of defect reduction is the preparation of visual work instructions.

Poor Product Design

Many defects can be traced to poor product design. In examining product design failures, look for cost restrictions, poorly understood in-service product performance requirements, poor materials' selection, little or no product performance testing, and poor supplier performance. Regardless of the root cause of poor product design, the cost for a part design change increases dramatically further into the value stream the product is before the defect is detected. The relative cost to mitigate a defect detected along the value stream using design engineering as a baseline of $1 is as follows:

- $1 product design engineering
- $2 product manufacturing engineering
- $4 production
- $5–$10 if the product reaches the customer

In some industries the cost could be significantly more. Many pharmaceuticals, for example, have limited shelf lives. If defect detection occurs at the customer, there may be insufficient time for return and repair or rework, requiring a complete write-off of the shipment. In this case, material/labor/facilities' costs plus profit are lost, not to mention the bad will created with the customer.

Weak Process Control

In all process environments, either you control the process or the process controls you. Weak process control can stem from several sources, including deficiencies in materials, machines, manpower, methods, or measurements. It is easy for weak process control to creep into your processes. The three telltale signs you need to work on process control are defects, rework, and high scrap rates.

Deficient Planned Maintenance

Poor equipment maintenance is often a cause for defective products. The justification for not completing planned maintenance can range from not enough time to do total productive maintenance or autonomous maintenance, cannot afford to have production down, to equipment repairs are too expensive, to name a few. In the long run, effective equipment maintenance is always less expensive than equipment breakdowns due to poor maintenance, the cost of scrapping defective parts, or the added cost of rework.

How to Identify Defects

Defects are often only defined as something that an employee can tangibly see in the product. However, a defect is better described as anything that contributes to a product not meeting exactly what the customer wants. The list of questions in Figure 7.8 should help you begin to expose a number of possible defects. This list could be greatly expanded; however, it should give you an idea of how to begin your search for anything that may possibly affect your product or service and be considered a defect.

Waste 4: Extra Processing

Processing waste is described as any effort that adds no value to the product or service from the customers' viewpoint. These are steps that may not be necessary. Many examples of processing waste are present in any product or service delivery. For example, let us consider a product with 15 steps. If a subassembly at process step 3 is not assembled correctly, the product moves through the facility and the problem is initially detected at assembly step 17. Unfortunately, steps 5, 7, 9, and 11 may need to be disassembled and the correction made before step 13 can proceed. These repeated steps are rework and take valuable time away from employees who could be working on new products. This extra effort is called *processing waste*.

Defect Detection Questions

- Materials
  - ☑ Are the proper materials being used?
  - ☑ Are the material specifications adequate?
  - ☑How many materials are needed?
  - ☑ Are we purchasing excessive supplies of any kind?
  - ☑ When are they needed?
  - ☑ Where are they stored?
  - ☑ How are they handled?
  - ☑ How are they moved to where we create value for the customer?
- Machines
  - ☑ Is current machinery adequate? Optimal?
  - ☑ Where are they located?
  - ☑ Do we have obsolete equipment in the area?
  - ☑ Is there a defined maintenance program and schedule?
  - ☑ Is time allowed for proper equipment maintenance?
  - ☑ Do you have a daily 5S clean and inspect procedure?
- People
  - ☑ Are special personnel needed?
  - ☑ How many?
  - ☑ What specific skills are needed?
  - ☑ Do you have people cross-trained at each position?
- Methods
  - ☑ What methods do we use?
  - ☑ Do you have visual work instructions for every operation?
  - ☑ Are files (or work) awaiting excessive signatures or approvals?
  - ☑ Are files awaiting task completion by others?
  - ☑ Do we have any obsolete files in the area?
  - ☑ Do we have data entry errors?
  - ☑ Do we have standardized pricing, quoting, billing, or coding?
  - ☑ Do we forward partial documentation to the next process?
  - ☑ Do we ever lose files or records?
  - ☑ Do we ever encounter incorrect information on a document?
  - ☑ Are methods easy to understand, learn, and use?
  - ☑ How do we train our staff?
  - ☑ Does poor performance signal a requirement for retraining?
- Measurements
  - ☑ What measures do we use?
  - ☑ Are there clear strategic measures?

FIGURE 7.8
Defect detection questions.

☑ Do all tactical process measures “roll up” to strategic measures?

☑ Are all of these measures performance based?

☑ Any dead cost measures?

☑ Do we have key process input (KPI) measures?

☑ Do we have key process output (KPO) measures?

☑ Do we have good in-process measures?

FIGURE 7.8 (*Continued*)
Defect detection questions.

What Causes Processing Waste?

Processing waste can stem from many sources and is often present regardless of the activity type. Processing waste is predominantly waste that is found in front-office areas, such as order processing, information gathering and dissemination, and all accounting functions. It is also dominant in service industries where service-delivery requirements may be ill-defined or difficult to achieve. Industries such as the medical field, janitorial, or food-service industries may have extensive processing waste from several apparent causes. These causes can be classified into a few basic areas listed below. Each is followed by a brief description.

- Product changes without process changes
- Just-in-case logic
- True customer requirements undefined
- Overprocessing to accommodate downtime
- Poor communication
- Redundant approvals
- Extra copies/excessive information

Product Changes without Process Changes

When a product or service is changed, production staff or service personnel need to be properly informed. For example, visual work instructions or service-delivery instructions need to be modified and training conducted for the new process. In many growing companies, products or services are changed frequently, often with little or cursory regard for production or service-delivery personnel. This can be a major source of processing waste for a range of product or service quality issues.

Just-in-Case Logic

Just-in-case logic is exactly what it sounds like. You make more product *just-in-case*—you fill in the blank, for example, just-in-case the machine breaks down, just-in-case your suppliers do not send enough raw materials, just-in-case your customer orders more than you can make or deliver on time, and so on. There are many reasons for using just-in-case logic, and they all contribute to decreased company profitability! Just-in-case logic is a primary cause for overprocessing waste.

True Customer Requirements Undefined

When customer requirements are poorly understood or not documented properly and employees are not adequately trained on requirements, extra processing is bound to occur. An LSS process starts with a clear fundamental understanding of customer requirements. This typically involves a critical to quality (CTQ) assessment and definition of all product or service requirements from the customer standpoint.

Overprocessing to Accommodate Downtime

In traditional organizations, one belief is that people must be busy on production at all times. Consequently, managers order people to produce products even when none are required by a downstream customer. This results in overprocessing and creates overproduction and excess inventory. Alternatively, this time should be used for additional LSS training, cross-training programs, or other continuous improvement activities.

Poor Communication

Poor communication is typically one of the top reasons that organizations lose effectiveness. Communicating information along the entire value stream is critical for a great customer experience. The earlier in any process that the communication breaks down, the worse is the resulting waste. A typical communication cycle includes the following:

- Identifying CTQ customer requirements
- Transitioning customer requirements into product or service specifications
- Engineering the product or service
- Creating instructions for producing the product or service
- Product or service delivery to the customer

Redundant Approvals

Although there is a need to have some cost and quality control approvals in any process, it is easy to stifle the process by requiring redundant approvals that can dramatically increase lead time and increase total product cost. After reviewing many approval procedures over the years, this has been identified as a significant example of extra processing.

Extra Copies/Excessive Information

Information sharing can be a significant source waste. How many reports are printed and not read? If they are read, how many items are actions taken on? Then there are charts, graphs, memorandums, e-mail distributions, and so on, leading to information overload for employees. One example is what can essentially be described as the e-mail soap opera. The saga begins with one controversial statement or aspect that was sent to too many employees. It quickly evolves into long series of clarifications and reclarification e-mails, with each e-mail raising more questions than it answers. These types of e-mail dialogues rapidly consume significant employee time and energy of everyone involved.

How to Identify Processing Waste

The learning to see processing waste checklist presents some basic questions to uncover process waste (see Figure 7.9).*

* Having a direct impact to the bottom line, quality defects resulting in rework or scrap are a tremendous cost to most organizations. Associated costs include quarantining inventory, re-inspecting, rescheduling, and capacity loss. In many organizations the total cost of defects is often a significant percentage of total manufacturing cost. Through employee involvement and continuous process improvement, there is a huge opportunity to reduce defects at many facilities. In the latest edition of the Lean manufacturing classic *Lean Thinking*, underutilization of employees has been added as an eighth waste to Ohno's original seven wastes. Organizations employ their staff for their nimble fingers and strong muscles but forget they come to work every day with a free brain. It is only by capitalizing on employees' creativity that organizations can eliminate the other seven wastes and continuously improve their performance. Many changes over recent years have driven organizations to become world-class organizations or Lean enterprises. The first step in achieving that goal is to identify and attack the nine wastes. As many world-class organizations have come to realize, customers will pay for VA work, but will never knowingly or willingly pay for waste.

Waste of Extra Processing Checklist			
Process:	**Date:**		
Description	**Yes**	**No**	**Apparent Cause**
Is there visible rework being conducted?			
Do we measure the amount of rework?			
Do we collect data on labor and materials associated with rework?			
Are we duplicating reports or information?			
Are we entering repetitive data?			
Do we have many forms with duplicated data?			
Are we doing more work than is required for that process?			

FIGURE 7.9
Waste of extra processing checklist.

Waste 5: Waiting

Waiting waste is often described as time waiting for something to happen or occur. This could be human waiting time, machine waiting, or materials waiting to be processed. When this waste occurs, ultimately it is the customer who is left waiting as lead times expand to accommodate the numerous waiting steps in your processes.

What Causes Waiting Waste?

Waiting time waste may be caused by several sources. Some examples include materials conveyance delays, machinery or equipment breakdowns, operators working too fast or too slow, and an insufficient number of employees, to name a few. Causes of waiting waste include the following:

- Raw material outages
- Unbalanced scheduling or workloads
- Unplanned downtime for maintenance
- Poor equipment or facility layout
- Long process setup times
- Misuses of automation
- Upstream quality (flow) problems

Raw Material Outages

A prevalent root cause of waiting waste is raw material outages. Poor purchasing practices or purchasing measures can often lead to inadequate raw materials' inventories. Without raw materials you cannot add value for your customers and you bear all the material-related liability. For example, if you make a product that has 25 components and you are out of 2, you cannot build your product. However, you have the inventory carrying costs for the 23 components in stock. In addition, allowing outages to occur almost guarantees some of the other wastes, such as overproduction and extra processing. You cannot build the entire product, so you start building parts, and soon mountains of incomplete subassemblies begin to appear around the facility as work-in-process (WIP). Raw materials outages and management can be an LSS project focus topic.

Unleveled Scheduling and Unbalanced Workloads

Similarly with overproduction, unleveled scheduling and unbalanced workloads can both lead to the waste of waiting. These conditions typically occur in forecast-driven environments. In areas where the workload is not balanced properly between two or more process steps, one step will have excess capacity whereas the next may have excess demand. In the end, you wind up with equipment, materials, and/or manpower waiting.

Unplanned Downtime for Maintenance

When a machine breaks down unexpectedly, there is a significant opening for the waste of waiting. In addition, during the waiting period overproduction or extra processing can follow when management decides the result of finding things for employees to do until the equipment is back on-line. These extra activities are often viewed as steps that would be necessary to complete and not as waste. However, as shown in overproduction and extra processing, these are truly wastes and should be measured and subsequently eliminated.

Poor Equipment or Facility Layout

Equipment placement and facility layout are primary sources of the waste of waiting. The position of equipment within a facility is frequently decided based on (1) shortest run from electrical service, (2) currently

open floor space, and (3) a position near similar equipment, or in an expansion location. None of these criteria are based on a proper manufacturing sequence or limiting any of the nine wastes. Poor equipment and facility layout can result in significant motion, transportation, and waiting wastes.

Long Process Setup Times

When the time to change equipment over to a different product is long, this can be a contributor to the waste of waiting. Although long process setup times can vary depending on the equipment and complexity of the transition, process setups are necessary for most equipment. Every minute, hour, or day consumed by setup is time permanently lost to waiting and contributes to lower productivity and profitability.

Misuse of Automation

A common mistake that owners or managers often make is that they want to see expensive equipment running, not sitting idle. This misuse of automation can cause the waste of waiting. Not very often does customer demand exactly meet machine capacity. One of the most difficult challenges for LSS practitioners is to change the misconception that the machine must always be running. In environments where there is a combination of automated and manual production, the misuse of automation at one process step creates the unleveled scheduling and unbalanced workloads at downstream process steps.

Upstream Quality (Flow) Problems

Product quality issues can lead to a number of wastes. Two prominent wastes are extra processing and waiting. In the case of many complex products that contain subassemblies, as soon as quality issues are uncovered upstream, remaining downstream steps are caught in a waiting game for completed quality subassemblies. Every process step should target 100% first-pass quality.

How to Identify Waiting Waste

Waiting waste can be present across the entire value stream. Regardless of the reason for the waste of waiting, the objective of learning to see is to identify where and when in the process waiting waste occurs. The

Waste of Waiting Checklist			
Process:	**Date:**		
Description	**Yes**	**No**	**Apparent Cause**
Is work delayed from a previous process?			
Is there misuse of automation?			
Do you have unbalanced workload?			
Do you have unleveled scheduling?			
Are there materials shortages?			
Do you have absenteeism—too few workers?			
How about too many workers?			
Are there frequent unexpected machine downtimes?			
Is your facility layout effective?			
Do you have upstream product quality issues?			
Do you have long process set-ups?			

FIGURE 7.10
Waste of waiting checklist.

checklist in Figure 7.10 is an effective tool to identify where, when, and how the waiting waste is occurring in a process.

Waste 6: Motion

Waste of motion occurs when there is any movement of people or information that does not add value to the product or service.* The ultimate objective in an LSS organization is to properly connect materials, machines, man/woman power, and methods. When this is achieved, there is a state of continuous flow. Continuous flow is often credited with the highest levels of quality, productivity, and profitability. Wherever there are disconnects between two entities, for example, materials and people, the waste of motion is inevitable.

* This waste is related to ergonomics and is seen in all instances of bending, stretching, walking, lifting, and reaching. These are also health and safety issues, which in today's litigious society are becoming more of a problem for organizations. Jobs with excessive motion should be analyzed and redesigned for improvement with the involvement of plant personnel.

What Causes Motion Waste?

There are many possible causes for the waste of motion. Some of the major sources are the following:

- Poor people, materials, and machine effectiveness
- Inconsistent work methods
- Poor information management
- Unfavorable facility or cell layout
- Poor workplace organization and housekeeping

Poor People or Machine Effectiveness

Employee interactions with materials and machinery may result in the waste of motion. This happens when employees have to walk distances to pick up or deliver materials by hand. It can also occur when information must be hand delivered from one process step to another. One example may be delivering a completed order back to accounting to complete the billing cycle. Another example may be delivering a completed order to shipping for scheduled delivery.

Inconsistent Work Methods

Whenever work methods are not documented properly, a number of inconsistent and poor practices slip into any process. The best counter to inconsistent work methods is the creation of standard operating procedures or visual work instructions. These become the foundation of all effective employee training programs. In their absence employee learning occurs through the passing down of *tribal knowledge* known only to *experts* in your organization. Learning that occurs under these conditions is open to interpretation by the employee on *what to do next* or *how to do* specific activities in the process. This frequently results in several employees doing the exact same activity differently. Inconsistent work methods not only result in the waste of motion, but also are frequently the root cause of product- or service-delivery quality issues.

Poor Information Management

The transition of information between employees, departments, and customers often leads to the waste of motion. Information management systems that are not set up to make required information available to employees when and where it is needed often results in employees doing printouts and manual document transfers around the organization. As with many wastes, the waste of motion can also cause several other wastes.

For example, when shipping instructions for a specific customer are not completely defined in the information management system, an employee in shipping must stop to track down the proper information, which can require going to order processing or customer service to obtain the information. This initial waste of motion produces the waste of waiting and the waste of extra processing before the order can be properly shipped.

Unfavorable Facility or Cell Layout

If the facility layout is weak, the waste of motion will be present. By facility we mean any department in an organization, wherever value is created for the customer. The layouts of administrative areas, such as order processing, customer service, accounting, and warranty claims departments, are seldom considered as areas where waste can occur, but often are significant sources for the waste of motion. This is due to the frequent manual transportation of documents necessary in these areas, as well as an inordinate amount of information exchange required to produce your product or service.

In a production environment poor facility layout results in excess waste of motion regarding moving raw materials in a position to add value, securing tools and fixtures, or delivering materials to the *next process step*.

Poor Workplace Organization and Housekeeping

It never ceases to amaze me how little attention is paid to workplace organization and housekeeping. Managers would rather employees spend hours searching for tools, materials, documentation, and so on, than allow 30 min/day to maintain an organized work area. This philosophical fixation that every employee activity must be producing product is responsible for many of the wastes observed in organizations today. Every day managers can walk by piles of obsolete materials, in-process rework, and mountains of defective warranty returns, while continuing to allow no time for employees to correct the conditions that produced these results. All process improvement programs begin with workplace organization and housekeeping.

How to Identify Motion Waste

Motion waste can be present across the entire value stream. Regardless of the reason for the waste of motion, the objective of learning to see is to identify where and when in the process motion waste occurs. The checklist in Figure 7.11 is an effective tool to identify where, when, and how the motion waste is occurring in the process.

Waste of Motion Checklist			
Process:	**Date:**		
Description	**Yes**	**No**	**Apparent Cause**
Are all materials where needed?			
Do you have the proper material quantities?			
Are materials specifications correct?			
Are tools in good working order?			
Are all tools available?			
Is order documentation complete?			
Is shipping information complete?			
Do you have to search for files on the computer?			
Are you searching for documents in file cabinets or drawers?			
Are you hand-carrying paper work to another process or department regularly?			
Are you constantly reviewing the same manuals for information?			

FIGURE 7.11
Waste of motion checklist.

Waste 7: Transportation

Transportation waste is any activity that requires transporting parts and materials around the facility. Unlike motion waste that typically involves only people, transportation waste is usually reserved for action involving equipment to move materials or parts.* This equipment comes in many forms, such as carts, rolling racks, forklifts, golf carts, and bicycles, to name a few.

What Causes Transportation Waste?

Transportation waste can be caused by a number of factors. The major causes are the following:

* Transporting product between processes is a cost incursion that adds no value to the product. Excessive movement and handling cause damage and are an opportunity for quality to deteriorate. Material handlers must be used to transport the materials, resulting in another organizational cost that adds no customer value. Transportation can be difficult to reduce due to the perceived costs of moving equipment and processes closer together. Furthermore, it is often hard to determine which processes should be next to each other. Mapping product flows can make this easier to visualize.

- Poor purchasing practices
- Large batch sizes and storage areas
- Inadequate facility layout
- Limited understanding of the process flow

Poor Purchasing Practices

The largest contributor to transportation waste is poor purchasing practices. Many organizations measure their purchasing effectiveness on the dead cost/piece for raw materials purchased. This can lead to incredible waste throughout the organization, not just transportation waste but also the waste of overproduction, inventory, extra processing, and defects.

Let us consider a real-world example to show how non-Lean measures can drive non-Lean behavior within an organization. Let us say your organization has a program in place to drive the cost of raw materials down and John's, the purchasing department manager, bonus is dependent on a 10% reduction in raw materials costs. He has his heart set on that 60-inch plasma TV with surround sound installed before football season, so consequently he sees little else except achieving the dead materials cost reduction.

John begins to think: How can he achieve this predefined material cost reduction? Two actions immediately come to mind; both are non-Lean. First, he can go to current suppliers and try to get price decreases. These decreases usually require that the organization buy in larger volumes, which he does immediately. In fact, at the next manager's meeting John is eager to get a pat on the back from the boss and reports that he has secured a 3% material cost reduction in the first month of the program; the unnecessary raw materials, along with the corresponding inventory and transportation waste, begin to show up in receiving the very next week.

Second, he can search for secondary suppliers that are willing to provide supposedly equal raw materials. At first glance they appear to be equal in every way—specification, function, and quality. He begins to substitute some of these raw materials and again achieves more raw materials cost reductions that are, of course, well received by management. John achieves his bonus and spends Sunday afternoons in bliss with his favorite beverage and gridiron action—an apparent happy ending. Not so fast. In the next few weeks during production, some inconveniences arise because the new materials are not exactly like the original parts. This leads to some in-process defects that require rework or the waste of extra processing. In addition, weeks later returns begin from customers for poor product service in the field.

Because the sales price is based on typical labor standards, these extra production costs and warranty return costs do not appear on management's radar and consequently do not exist. Only after months, when management realizes the shrinking profit margins, does another costly search for the reasons begin. This is a classic non-Lean example of how non-Lean traditional measures can drive non-Lean behavior. In this case, what did John learn to see? Certainly not the waste! His behavior was being completely driven by his measurement system.

Large Batch Sizes and Storage Areas

The waste of transportation can also occur when you process large batches of product or set up large storage areas. Both of these decisions require that the materials be moved at some time. These moves invariably require people (materials handlers) and equipment (forklifts, carts, pallet jacks, flatbeds, etc.). This situation is almost always the symptom of a poor purchasing decision that was based on a non-Lean traditional management belief that organizations save money when they buy large batches of materials.

Inadequate Facility Layout

One of the primary causes of transportation waste is poor facility layout. Where you place equipment, how and where your materials storage areas are set up and regularly accessed, and your organization's purchasing philosophy all affect productivity and profitability. Proper facility layout can reduce lead time by up to 40%, and dramatically reduce the waste of waiting, transportation, and motion.

Limited Understanding of Process Flow

In every process there needs to be a thorough understanding of the materials, machines, man/woman power, or methods required to add value for the customer. A primary component of Lean—and a constant goal for LSS practitioners—is continued process development and deeper understanding of process knowledge. It is important to understand the best sequence of process steps to meet customer demand, such as: How are activities conducted? How fast is product needed? Where do materials get consumed? What are the fluctuations in manpower requirements? Is the correct type of equipment available? Is the equipment in working order? Having well-defined answers for these factors contributes to improved process understanding.

Waste of Transportation Checklist			
Process:	**Date:**		
Description	**Yes**	**No**	**Apparent Cause**
Are materials moved between buildings?			
Do you make large batches?			
Do you buy bulk raw materials?			
Do you have lots of forklifts?			
Do you have many other types of transportation equipment?			
Are materials stored long distances from where they are used?			
Are there multiple temporary storage areas?			

FIGURE 7.12
Waste of transportation checklist.

How to Identify Transportation Waste

The learning to see transportation waste checklist presents some specific questions that can help you uncover transportation waste (see Figure 7.12).

Waste 8: Underutilized Employees

The waste of underutilized employees often occurs when we fail to recognize and harness people's mental, creative, innovative, and physical skills or abilities. This is present to some extent in almost every company, even organizations that have been practicing Lean behaviors for some time. Much of this employee misuse stems from the management concepts previously discussed regarding traditional organization belief systems. Although many Western managers pay lip service to *our employees are our most valuable asset*, they are the first to philosophically look at employees as a liability, not an asset. Many are often quick to practice management by head count—this is the practice of stating that we will operate with a specific number of employees regardless of the number required to provide good performance for the customer.

What Causes Underutilized Employees Waste?

There are a number of causes of underutilized employees or people waste. Each of these stems from some aspect of traditional belief systems.

- Old guard thinking, politics, and business culture
- Poor hiring practices
- Low or no investment in training
- Low-pay, high-turnover strategy

Old Guard Thinking, Politics, and Business Culture

Old guard thinking, politics, and general business culture often stifle using employees' creative skills or producing innovative assignments that could result in significant process improvements. Unfortunately, in many organizations an employee's perceived importance to the organization is generally directly proportional to his or her salary or directly linked to his or her title. This is common in the United States and seldom seen in Japanese companies.

Poor Hiring Practices

Most human resource departments are faced with the difficult task of how to attract and retain skilled employees. Poor hiring practices usually stem from the structure of the department and management's mandate for critical components of the hiring process, such as pay level, required skills, or required experience. All of these could hinder getting the best candidate for the position.

There are many factors that can go into poor hiring practices. A few common mistakes include the following:

- Inadequate job advertisements
- Position definition
- Nepotism
- Not matching skills to position requirements
- Not understanding the technical aspects of job requirements
- Inability to identify the skills necessary to add value to a position

Low or No Investment in Training

Good data on training time, although readily available from many sources, is often difficult to translate to an organization. The American Society for Training and Development puts the dollars per year per employee at about $1,400. For a $40,000/year employee, this equates to about 7.5% of annual salary. It has been cited in the literature that

top-performing companies spend approximately 4%–6% of annual salary on training. It has also been reported that average American companies spend less than 5% on employee training. LSS organizations often approach 10%, with 3%–4% of annual salary direct spending on new training and 6% employee time committed to improvement activities.

All companies tend to view training differently. One observation is unavoidable—poor-performing companies tend to invest little or nothing in training, while higher-performing organizations invest in training and focus on process improvement.

Low-Pay, High-Turnover Strategy

Another common trait of traditional organizations is the *low-pay, high-turnover rate* philosophy. This is characterized by hiring to a specific hourly or salary level regardless of skills, and living with the performance that pay rate returns. Because the conditions are poor, employees either leave to pursue a better opportunity or are let go by the company for myriad reasons. This is an internally focused philosophy and completely ignores the voice of the customer.

How to Identify Underutilized Employees Waste

The learning to see underutilized people checklist in Figure 7.13 points out some questions you can use to assess your current employee use and expose some apparent causes for lack of effective employee use.

Waste 9: Behavior

Behavior waste is any waste that results from human interactions. It is present to some extent in all organizations. It can be minimal in truly LSS organizations; however, it can be pervasive and devastating in traditional organizations. Behavior waste naturally flows from an individual's or a company's inherent beliefs. "The concept of waste has not yet been effectively extended to the self-defeating behaviors of individuals and groups of people in the workplace."[4]

Behavior waste is a root cause of the other eight common wastes. Many of the previously described wastes alluded to employee beliefs and behaviors as causes for waste generation. The identification and elimination of behavior waste is critical to any successful LSS initiative.

Waste of Underutilized Employees Checklist			
Process:	**Date:**		
Description	**Yes**	**No**	**Apparent Cause**
Do we know the true experiences and capabilities of our employees?			
How easy is it to move employees to special assignments?			
Is your process so fragile that employees cannot be assigned to special projects?			
Are employees in positions they were trained to do?			
Is there active improvement-idea generation from all employees?			
Are employees allowed to experiment with process improvements?			
Can employees assist in other areas as needed?			
Do managers place obstacles or restrictions on employees?			
Are employees empowered to take action in their area?			
Is there a "Can't Do" atmosphere?			
In there a "Can Do" atmosphere?			

FIGURE 7.13
Waste of underutilized people.

How to Identify Behavior Waste

Behavior waste is classified as either personal (yourself) or people (between two or more employees). Identifying these behavior wastes in your organization is the first step to elimination of this disruptive waste.

Personal Behavior Waste

Personal waste is waste that comes from within oneself. It stems from the way you view yourself, your goals and objectives, or possibly your position in the organization. Oftentimes personnel who prefer a Theory Y organization (empowered-employee environment) and are working in a Theory X organization (command and control environment) feel underappreciated. As a consequence, they become an underutilized employee and can exhibit low morale. The personal waste they generate comes directly from their individual belief system. Gossip, self-imposed barriers, deceptions, and ego are a few of the many examples of personal waste.

Personal waste has been described as the little voice inside your head that provides constant running (negative) commentary. It can control an employee's inability to suspend judgment and projects unresolved internal conflicts of the employee. It does not take much personal waste to bring continuous improvement to a screeching halt. In fact, personal waste will restrict process improvement and Lean deployment at any process step that touches this employee, which is basically your entire value stream.

People Behavior Waste

People waste has to do with relationships between fellow employees. This includes between department managers and senior managers, as well as the manager-employee relationship. Some categories of people waste include turf wars, fiefdoms, or politics. Some specific examples of what people say when they are exhibiting people waste are the following:

- "Bill's initiative is so stupid!"
- "Forget about what Jane says!"
- "John is impossible to work with!"

One can see how personal waste, when coupled with people waste, can stifle all process improvement.

SUMMARY

Learning to see variation and waste is a critical first step to improving quality, productivity, and profitability. Only after employees begin to learn to see waste and variation with new eyes can they identify previously unnoticed waste in the organization and effectively begin to eliminate the sources of waste and variation.

Processes add either value or waste to the creation of goods or services. The seven wastes originated in Japan, where waste is known as muda. The eighth waste is a concept tool to further categorize muda and was originally developed by Toyota's chief engineer Taiichi Ohno as the core of the TPS, which also became known as Lean manufacturing. The ninth waste—behavior waste—is by far the most damaging of all the wastes. The reason is simple: *Everything we think, everything we say, and everything we do* shape the behavior of all employees in our organization and gets them going in a direction of either creating value for the customer or creating waste.

To eliminate variation or waste in a process, it is important to understand exactly what waste is and where it exists, and to clearly view, measure, and limit variation. Although, activities can significantly differ between factories and the office workplace may seem to be a different world, or in service organizations where the product is actually a service, the typical wastes found in all these environments, and in fact in all business environments, are actually quite similar.

All forms of the nine wastes are highly costly to an organization because waste prohibits the smooth flow of materials and actually degrades quality and productivity. The TPS mentioned in this chapter is also referred to as just-in-time because every item is made just as it is needed. Conversely, overproduction is referred to as just-in-case. This creates excessive lead times, results in high storage costs, and makes it difficult to detect defects. The simple solution to overproduction is turning off the tap; this requires a lot of courage because the problems that overproduction or behavior wastes are hiding will be revealed. The concept is to schedule and produce only what can be immediately sold and shipped and improve machine changeover/setup capability.

For each waste, there is a strategy to reduce or eliminate its effect on an organization, thereby improving overall performance and quality, whereas at the same time lowering costs. Learning to see is all about learning to use these strategies and tools in a productive manner.

REFERENCES

1. Chet Marchwinski and John Shook, ed., *Lean Lexicon*, 4th ed., Lean Enterprise Institute, Cambridge, MA, March 2008.
2. H. James Harrington, Glen D. Hoffherr, and Robert P. Reid Jr., *Statistical Analysis Simplified*, McGraw-Hill, New York, 1998.
3. H. James Harrington, Praveen Gupta, and Frank Voehl, *The Six-Sigma Greenbelt Handbook*, Paton Press, New York, 2009.
4. M. L. Emiliani, "Lean Behaviors," *Management Decision* 36(9), 615–631, 1998.

8

Waste Quantification: Learning to Measure

> Not everything that counts can be counted…and not everything that can be counted counts.
>
> **Albert Einstein**

IN A NUTSHELL

As manufacturers and service organizations continue to adopt Lean principles, the process inevitably involves developing metrics for measuring their progress. If your company is on a Lean journey, where are you on that road? How well are you doing? What should you measure? Are you measuring too little or too much? The data that can be collected in a manufacturing plant or a service environ are almost endless, and the systems that companies use to assess where they stand run a wide and sometimes bewildering gamut and gauntlet of choices. The concepts contained in this chapter explore the design attributes of the Lean management performance measurement system required for the transformation to the Lean enterprise; and the process of quantifying and recording detailed measurements of various types of waste (muda) within the organization.

This chapter is organized with an introductory overview on measurement presented first. The overview is followed by two sections: the first is on measurement system theory that discusses the various philosophies on measurement and directs the reader to a number of possible supplemental readings on measurement. The second is on measurement system practice that defines a proactive approach employees in any organization can use to begin their journey from traditional measurement system to a Lean measurement system.

OVERVIEW

Arguments are made from the literature and the workplace alike that successful deployment of Lean practices, across different stages of the evolution of Lean thinking, requires a supporting Lean measurement system. The increase in scope of Lean practices at each stage of the evolutionary process increases the complexity in achieving the synchronization of measures across the enterprise subsystems. The research outlined in this book presents various attributes of the Lean measurement system required at each stage of evolution and further derives the key attributes for the design of your organization's Lean enterprise performance measurement system.

These three critical measurement attributes are the following: (1) enterprise-level stakeholder value measures, (2) the causal relationships across Lean performance measures at each level, and (3) a uniform and consistent set of supporting performance measures. Some detailed case studies are presented, which highlight several challenges in the Lean transformation from the perspective of measurement. The key challenges that we try to identify are (1) a disconnect between the performance measurement for the Lean practices and regular business practices hinder the adoption of Lean practices, (2) this disconnect exists because of the existence of both legacy performance measures and the new measures, (3) lack of understanding of the cause-effect relationship between performance measures across different enterprise levels poses difficulty in evaluating the impact of Lean-related efforts, and (4) use of nonuniform performance measures across various enterprise subsystems leads to non-Lean behavior.

The theory underlying Lean performance and outcomes measurement is based on the widely accepted performance measurement frameworks suggested for the design of enterprise performance measurement systems. Analysis of these frameworks reveals that none of the existing frameworks completely capture the desired attributes for the Lean enterprise measurement system. To design the system, our research suggests a conceptual design that explicates the use of various tools and techniques to address the critical attributes. To identify stakeholder value measures, this design demonstrates the use of stakeholder value analysis. Use of system dynamics modeling and structural equation modeling is also

suggested to establish, validate, and evolve the cause-effect relationships between performance measures. And to maintain a relatively healthy and uniform set of measures, the creation of measures dictionary supported by operational definitions is suggested. For the most part, our research has led us to empirically validate the modes presented in this book as a means and method for successful transformation and management of the Lean enterprise.

Background

The existing popular notion of calculating cost savings through every single twist and turn and nuance of the Lean journey misses the point of understanding why you need to be doing Lean in the first place. As Lean practitioners, we need to remember that Lean is a business philosophy and strategy that enables a company to compete much more effectively in this global marketplace. If management is asking for return on investment for 5S activities, we maintain that you have a lot more explanation and education to conduct with your leadership team before you embark on the Lean measurement journey.*

Many of our manufacturing, service, nonprofits, and government clients concur: "Avoid going down that road at all costs," said a continuous improvement manager at a client organization. "If you can directly tie in cost savings, by all means record it. Otherwise, use the tools, achieve direct results, and compare. Is your management team so dense that they need you to put some 'bogus' dollar figure next to a Lean initiative so they know freeing up square footage is a good thing? Can they not intuitively understand that reducing setup time from eight hours to one hour is beneficial? Trust me, if you go down this road, you will regret it."†

How many times have we all read that you cannot really be Lean until you measure Lean? If the conclusion is that in an ideal world, every

* Jamie Houghton, the once-Chairman of Corning, has said that when management does not get it, then the CEO needs to sit down and 'splain it to them, up close and personal. What he was referring to was the need to provide clear explanations ('splain) to help them get it, to see the big picture. Once their attention is secured, proper measurement tools and techniques can be discussed in a positive and noncross-purposeful manner.

† Source: Comments made by industry leaders and the specific individual names are withheld. As reported by the IndustryWeek 1000 (this is IndustryWeek's report on the 1000 largest publicly held manufacturing companies based on revenue). For service organizations, the numbers and conclusions are less precise and are not covered in this IndustryWeek 1000 Survey.

company implementing Lean principles would immediately toss away current measures and start from scratch, you would be wrong! There is usually strong resistance to changing performance measures when they are tied to incentive programs, performance appraisals, or simply have always been used. Also, enterprises today are evolving from traditional, vertically integrated enterprises to dynamic, network-centric horizontally integrated enterprises. This evolution has resulted in an increase in size, scope, and complexity. Traditional fields of measurement study focus on the use of decomposition approaches to study enterprises through individual lenses such as strategy, organization design, and theory of the organization, to name a few.*

The engineering systems lens views the enterprise as *a system of systems* that consists of multiple interconnected and interacting systems such as supply networks, manufacturing systems, human resource development, information systems, accounting, and strategic planning. This perspective provides a deeper understanding of the synergistic relationships across various systems within the enterprise, and provides insight into how value is delivered to constituent stakeholders. Stakeholders with high expectations, the intense competitive environment fueled by the global economy, commoditization of products and services, increased information availability, and industry consolidation all have created a turbulent environment of change for enterprises. To adapt to such a dynamic environment and enhance overall performance, enterprises deploy a variety of system-change initiatives in addition to Lean: initiatives such as total quality management (TQM), just in time (JIT), Six Sigma, process reengineering, and flexible manufacturing to name a few. These system-change initiatives extend across functional and organizational boundaries to include customers and suppliers, resulting in the transformation from a functional enterprise to a process enterprise. However, improper use of these system-change initiatives, either through a lack of understanding of process interdependencies or through focus on an individual stakeholder, results in optimization of performance at the subsystem level as opposed to optimization at the enterprise level.

Lean-based-enterprise-level performance improvement requires a radical rethinking of how we manage enterprises through the use of *Lean*

* These approaches enable a deep understanding of the measurement of specific aspects of the enterprise; however the resultant big integrated picture view of the enterprise is often lost in the measurement process.

principles and practices. For example, in the last 15 years, the application of Lean principles has evolved from the production cell level to the value stream level and finally to the Lean enterprise (or organizational) perspective. Truly embracing and measuring Lean principles and practices at the enterprise levels requires massive transformation. These transformation efforts include removing functional boundaries, process redesign, integrating across organizations, empowering people, involving all stakeholders in the value delivery process, and culture change at the DNA level. The transformation to a Lean enterprise is a strategic approach that is intended to allow an enterprise to outperform its rivals, based on the manner in which it plans, organizes, controls, and executes its activities. The ultimate objective of a Lean enterprise is to deliver value to all its constituent stakeholders.

MEASUREMENT SYSTEMS THEORY

Lean Performance Measurement

In this global business world of the twenty-first century, there are good, solid reasons to question whether we are measuring the right things. At the very least, we should thoroughly understand the strengths and weaknesses of the measures we are using to guide business decisions. We will explain how performance measures appropriate for Lean enterprises differ from those in traditional organizations. We will further describe some key dimensions of good Lean measurement and offer some tools to help managers evaluate current performance measures from a Lean viewpoint. Finally, we will share how managers at client organizations are using measurement tools to speed the company's transition to a Lean production and fulfillment environment and have enhanced assembly line, service chain, and back office productivity without additional resources.

Performance measures serve multiple purposes: they communicate, motivate, clarify, and evaluate. Senior management uses written statements to describe a company's vision, mission, and strategic objectives, and management accountants use performance measures to help clarify these written statements and provide specific direction for decisions. Measures track an organization's progress toward its goals and objectives. Many organizations assign responsibilities to units and managers

and then use measures to assess accountability and reward performance. These measures can be lag indicators that provide feedback on what has happened or lead indicators that measure progress toward strategic objectives. Basically, performance measures provide information and feedback to support the decision making necessary to meet strategic objectives. Therefore, aligning measures with the company's designated strategy is critical, and is one of the reasons why policy deployment is becoming so popular in Lean organizations.

Many traditional performance measurements are anti-Lean. For example, in a plastics manufacturing facility, the desired machine utilization was 92%, and any result below that level attracted close scrutiny by corporate managers. This metric was a heavily weighted portion of the plant manager's performance appraisal, because the general belief was that to meet objectives it was critical to keep all machines making product. Increased capacity utilization would reduce manufacturing variances and drive down product cost. This culture encouraged, and even rewarded, producing excess inventory because it was in the plant manager's best interest to keep machines running. This is completely opposed to Lean principles of flow and pull where customer demand, not internal standards, triggers production. Traditional measures do not align with Lean principles because they were developed in a world where only managers make most decisions and where it was believed that efficiency and productivity were the key drivers of good performance. In Lean enterprises, cell and value-stream team members make most decisions, which revolve around providing customer value in a timely fashion as well as smooth product and information flow. These empowered team members need current information to make decisions, and performance measurements clearly must align with the company's Lean strategy. Many good resources suggest completely redesigning strategic performance charts—ripping out the old measures and replacing them with new Lean measures.

We absolutely agree this approach is best, but a complete redesign is not always feasible. Sometimes circumstances require a smaller beginning. Some businesses that implement Lean fundamentals are parts of conglomerates where the parent company has a measurement system in place and compels all subsidiaries to report on the required basis. For example, one Lean manufacturing company that is a subsidiary of a much larger conglomerate measures and reports productivity even though the measurement motivates anti-Lean behavior. In most cases, performance measurement provides the essential links between

strategy, execution, and ultimate value creation and delivery. The Lean enterprise perspective looks at multiple functions, processes, programs, and organizations in the extended enterprise as a *system of systems*. There are a myriad of issues that arise as Lean principles and practices promulgate throughout the enterprise, and they often highlight the need for systemic change in the enterprise. To incorporate requisite systemic changes while simultaneously managing strategy formulation, execution, and ultimate value creation and delivery, changes in performance measures are needed, and corresponding support structures and processes have to be developed.

Successful deployment of the Lean enterprise approach is not limited to the transformation of actions. However, corresponding change and systematic design of a supporting performance measurements system is an imperative to synchronize those actions. Deployment of the Lean enterprise approach is a journey of continuous learning and transformation.

From Lean Production to the Lean Enterprise

For many organizations, the resistance to change is strong. When new measures are proposed, they are met with comments like "we have always measured it this way!" This resistance to change is rooted in strong non-Lean belief systems. This resistance may also be because employees have mastered manipulating traditional measures that are tied to a reward system. That is why many Lean enterprises slowly introduce changes to minimize employees' resistance. Whether through this gradual evolution or through abrupt immersion, to reach their full Lean potential companies must replace traditional performance measures with those that reflect Lean strategies and motivate employees to achieve those strategies. A good measure enhances the understanding of the business environment, helps identify problems, and provides relevant information to support decision making.

We will offer an evaluation tool to assess measures, ensuring they are consistent with the five principles of Lean thinking: customer value, value stream, flow and pull, empowerment, and perfection. The following summarizes these principles and their associated measures*:

* For a thorough discussion, you can refer to IMA's statement of management accounting, Lean enterprise fundamentals.

Customer value: Lean enterprises continually redefine value from a customer's standpoint. The product or service provides measured value when it meets the quality, costs, and time needs of the customer.

Value stream: The Lean enterprise is organized in measurable value streams. A value stream is the sequence of processes through which a product is transformed from raw materials to a finished product deliverable to the customer.

Flow and pull: In a Lean enterprise the customer order triggers or pulls production. Once started, the production process is designed to maximize the flow or throughput of the value stream and to minimize production time measures.

Empowerment: Lean enterprises' employees are empowered with the authority to interpret information and to take necessary actions. They are expected to make quality-related decisions and to collaborate with one another in a team environment to improve the process.

Perfection: Lean enterprises seek to measure perfection, defined as 100% quality flowing in an unbroken fashion at the pull of the customer.

Assessing Your Current Measurement System

The assessment tool approach leads employees to consider Lean principles and three attributes of good measures: technical, behavioral, and cultural attributes,* attributes are the inherent characteristics embedded within a measure that influence the user's interpretation and potential actions. This tool

- Provides a scaled assessment of how well a measure serves the organization
- Promotes logical and methodical consideration of the measure's characteristics
- Offers insight into the measurement system's limitations and strengths from a Lean perspective
- Promotes discussion concerning the measure's appropriateness and how it can be improved

* Originally defined by Shahid Ansari, Thomas Klammer, Jan Bell, and Carol Lawrence in *Strategy and Management Accounting.*

The assessment tool approach is designed to be completed for a single measure and repeated for additional measures.* It usually consists of three sections, one for each attribute of a good measure. Each section briefly describes the attribute to create a common starting point for all users. The first questions stimulate in-depth thought about the purpose, calculation, and use of the measure in a Lean environment. Technical Supplement 2 shows how some of the questions map back to the Lean principles and the three attributes of a good measure. The following is a linkage of the Principles of Lean to the technical, behavioral, and cultural attributes described and outlined in this chapter.

Principles of Lean	**Technical Attributes**	**Behavioral Attributes**	**Cultural Attributes**
Customer value	Does the measure relate to customer service?	How does the measure relate to the business's strategic goals?	How does the measure reflect value as defined in customer's eyes?
Value stream	Is it a functional or process-oriented measure?	Where does the measure focus attention?	Does the measure encourage continuous improvement at the value-stream level?
Flow and pull	Does the measure promote a smooth workflow?	How does the measure to employee output?	Does this related measure encourage one-piece flow through cell?
Perfection	Does the measure change between periods?	How well is the measurement goal communicated?	Does the measure promote the elimination of steps or waste?
Empowerment	Does the measure encourage workers to take action?	How widespread is the adoption of measurement goals to encourage Lean practices?	Does the measure encourage but-in for results among worker levels?

* The Technical section poses questions to thoughtfully consider the type of information derived from the measure. Employees identify what decisions are influenced by the measure, what activity driver is being measured, and which costs are being monitored. Employees also consider whether the measure promotes smooth workflow and relates to customer service. These questions highlight characteristics of Lean principles as well as the technical attributes of a good measure. For example, the flow-and-pull principle of Lean states that the production process is designed to maximize the flow or throughput of the value stream. The tool reflects this principle by directing employees to think about how the measure relates to bottleneck operations that can inhibit smooth flow.

The survey users then review their answers and then complete the assessment portion, which consists of five statements about the measure. Each employee scores his or her level of agreement with these statements on a five-point scale, and then the scores are averaged for each attribute. Based on these results, your organization will have a fairly clear picture of how Lean your current measurement system is. Now let us discuss the technical attributes of Lean measures and highlight sections of the assessment tools.

Technical Attributes of Lean Measures

Technical attributes of a measure refer to its ability to enhance the understanding of the phenomena being considered, and to provide relevant information for strategic decisions. In a Lean organization, managers understand that operating results are a function of how processes are organized. *A process is a connected set of activities and tasks performed to produce a product or service.* To manage Lean organizations, managers need measures that are process focused as well as outcome focused. Ideally, the organization's accounting system should aid in the understanding of what causes unwanted costs, why unproductive or idle capacity exists, and how the various parts of the value chain are related. However, accounting systems rarely do, which is why a Lean focus is needed.

Lean measures need to be decision-relevant, meaning they must provide information that changes and improves judgment and critical thinking. In a Lean enterprise, where employees seek continuous improvements, the accounting measures can assist work-process redesign by identifying nonvalue-added or unsynchronized activities that do not address customer requirements. The measures can also lead to better distribution of resources by identifying and monitoring process bottlenecks. The adoption of Lean philosophy at different levels of the enterprise leads to change in practices and subsequent actions which in turn require change in the supporting performance measurement system.

Deployment of Lean practices at the production process level involves synchronization of multiple tasks and activities. The operations across the production process are synchronized by the performance measurement system, such as visual management system, which incorporates the interdependencies and performance across the tasks and activities. As the application of Lean practices evolves from the production/fulfillment

process to the enterprise level, it requires interdependent subsystems across the enterprise, such as functions, processes, and activities to operate synchronously. With the increasing scope, the interdependencies among the subsystems become more complex. Thus the successful deployment of Lean practices at the enterprise level requires a Lean measurement system that incorporates performance measures to support the Lean practices, facilitates the communication of performance and outcomes across subsystems, and captures the interdependencies among the subsystems.

Technical Attributes of Good Measures

These refer to the measurement-related qualities desired in the information. There are two key properties of good measures: decision relevance and process understanding. Information is relevant to a decision if the information changes and improves the quality of decisions and critical thinking. Lean measures increase process understanding if they consider an entire process rather than a single functional unit, because work flows horizontally across units and functional measures do not provide information needed to perform work. The following questions should be asked to help scope out the technical aspects of good Lean measures:

1. Who uses this measurement information?
2. What decisions does the measurement influence?
3. Does the metric change between periods (e.g., quarterly or annually)?
4. Is it a functional or process-oriented measure (e.g., single department or multiple departments)?
5. Does this measure promote a smooth workflow?
6. Is the measure related to a bottleneck process?
7. Does this measure relate to product or service quality?
8. Does the measure provide information on the causes of defects?
9. Does this measure relate to customer service?
10. What activity driver does this metric measure?
11. Which costs does this measure monitor?
12. Does the measure tie cost to product or service performance for the customer?
13. How major or minor is this cost with respect to total production costs?

In attempting to further focus these 13 questions, this chapter looks at the evolution of Lean measurement practices across three different stages: Lean production process, system change initiatives, and the Lean enterprise. Development in the characteristics of the Lean measurement system for the successful implementation at each stage is presented based on client best practices and a detailed literature review. A discussion on practices for creating the Lean enterprise ensues, along with the characteristics of the Lean measurement system required to support the Lean enterprise, are covered in some detail.

As previously mentioned, the idea of Lean originated in the context of the manufacturing environment from the work of Taiichi Ohno at Toyota. The application of Lean principles first appeared in the domain of engine manufacturing, and quickly expanded to automotive manufacturing and, finally to the complete production process. Ohno's key contribution was to define the three types of activities occurring in the production process: *value-added work, nonvalue-added work, and waste* (Ohno 1988). The way of managing the production process by continuously removing waste and nonvalue-added work was largely defined as Lean production process.

Lean Production Measurement Process

The objective of the Lean production process is to continuously reduce the waste in human effort, inventory, time to market, and manufacturing space to become highly responsive to customer demand while producing world-class quality products (Phillips 2000). In the past several years, many books and journals have published a number of successful Lean production practices. The boundary of the Lean production process is limited to the production line, with close coordination or overlapping the supplier and customer activities and a distant relationship with other functions of the enterprise.

Seven common Lean production measurement practices have been identified from the literature.*

* Shingo 1992; Koufteros et al. 1998; White et al. 1999; Pavnaskar, et al. 2003; Carreira 2005; Shah and Ward 2003; and Maskell and Baggaley 2004. Also see the Wikipedia definitions and detailed description.

1. Measurement of shop-floor employee involvement
2. Reengineering setup time and cost
3. Cellular manufacturing measures
4. Quality circles measurement systems
5. Preventive maintenance measurement
6. Measurement of suppliers
7. Pull production measures

These measurement practices are interdependent and are implemented across multiple tasks and activities within the production process. Increased interdependence among the tasks requires improved visibility of performance across the production process to successfully deploy Lean practices. For instance, managing the pull production in a work cell depends on the performance of the preceding activity and the customer takt time. The continuous improvement efforts are carried out via involving shop-floor employees in problem identification, problem solving, and decision making. To empower employees in decision making requires more open communication and better understanding of the cause-effect relationships across the tasks/actions. In addition, to support the shop-floor employees in problem solving and to encourage the use of Lean practices, supervisors need access to the shop-floor performance information. The performance measures and the supporting system facilitate the communication and coordination, besides monitoring and control, required for the deployment of Lean practices.

Underlying the old truism that what gets measured gets done is the fact that measurements are used to influence behavior. Many Lean experts (including the authors) warn that it is all too easy to deploy metrics in a company that have the unintended consequence of driving anti-Lean behavior. For example, if a plant falls behind on overhead absorption for a quarter, as a manager there is only one action you can take to improve that measurement, and that is to build more inventory, whether it is needed or not. The traditional measurements that manufacturing has been held to by finance tend to actively hurt their Lean initiatives.

This disconnect is helping to fuel the interest in Lean accounting, where companies look at value stream performance in a way that supports and promotes Lean behavior. Lonnie Wilson, a Lean manufacturing

consultant and author of *How to Implement Lean Manufacturing** says it is difficult, if not impossible, to assign a general Lean score to companies because their operations and competitive situations differ markedly. He urges companies to adopt two primary yardsticks—track their own efforts to see if they are making progress and compare their efforts to their competition. Wilson notes, "In the end, the way you measure Lean is the ways you changed your behavior to make your fundamental business a better money-making machine and a more secure place for your people to work."

Although we usually do not recommend other author's books, this one is an exception as it is a practical how-to guide that can be used by plant managers, executives, quality managers, and production personnel to implement the Lean systems within their facilities. It not only addresses the strategy on how to implement Lean manufacturing but also addresses cultural change necessary for a successful transformation. In the end you have to sustain the gain and the book tells you what is necessary. What makes this monograph a standout from other Lean texts is that the book itself is written in a Lean style of writing. The author uses *points of clarity* to highlight important concepts within the book. In addition, he uses hundreds of visual graphics and tables that draw the reader's attention.†

Evaluating Your Lean Measures Technical Characteristics

Bill Smith, Industrial Scientific's manufacturing manager in the Americas, says that in keeping with the company's *employee first* philosophy, it trains employees thoroughly in Lean concepts and encourages employees to take

* As a management consultant we know once said, he really liked the fact that companies were trying to apply Lean because he got a lot of work as a result of the fallout from poor application. It is amazing that companies will try to adopt state-of-the-art manufacturing concepts, such as Lean, without a good understanding of what they hope to accomplish or even why the concepts have become popular. Part of the reason is that there is not much useful, practical advice on how to do it. This book by Wilson goes a long way toward filling that void. It is loaded with practical examples and exercises to clarify the application methods and benefits. It has some suggestions on getting started that can be measured and make money almost immediately. Chapters 2 through 5 provide a good overview (and there is a glossary for quick reference). Chapters 6 through 8 give a step-by-step procedure for getting started. Other chapters explain how to advance a process already in place and several chapters have excellent case examples. We especially liked Chapter 18 where there is a simple experiment with dice to show the effect of variation on plant capacity. We highly recommend reading this book because it helps to clarify the principles and how to apply them. We were also impressed with how much the case studies reinforced the principles and tied them to real events.

† Visual clues and organization is a key concept in Lean. In this book, we do not think you can turn two or more pages without being grabbed by a new visual aid to help make a point in the book.

a lead role in continuous improvement.* "We have empowered employees on the floor to go make changes to their processes, implement that change and report it to the production manager to get credit for it. We have 125 kaizen improvements per month. We know by doing this every day we're seeing improvements."

One of the metrics Industrial Scientific carefully monitors is on-time delivery. Smith recalls that when he was in sales with the company, two-week lead times for orders were typical. When employees studied the situation, they found that 80% of the products being sold represented 20% of the inventory. "We started building up that inventory and setting it up in kanbans," he says. "Now we have one- to three-day lead times."

Watlow Electric Manufacturing, headquartered in St. Louis, MO, is a custom designer and manufacturer of industrial electric heaters, sensors, controllers, and software.† Because the company primarily engineers products to meet customer specifications, there is considerable upfront development to generate the product design and produce it. Before 2005, the company had a 20- to 30-day manufacturing cycle, with half of that spent in design and administrative processing and the other half in actually producing the product. The company divided each plant into value streams and carefully analyzed each to understand current performance and how it compared to stakeholders' expectations. During the past 5 years, they focused on moving the work that is common to a product closer together, processing parts one by one, defect-free, so that they can produce them quickly and get them off our manufacturing floor to the customer.‡

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* Industrial Scientific started in 1976 as the research division of National Mine Service Company (NMS). The division was formed to develop methane detectors for underground mines. In 1985, NMS sold the division, and Industrial Scientific began independent operations on January 25 of that year. Investments in research and engineering led to patented technologies and state-of-the-art designs. In turn, the company's products became known as the most rugged and dependable in the world. In 2004, Industrial Scientific introduced iNet and the concept of gas detection as a service. The company has also emerged as a leader in safety data analytics. Customers now have access to information that helps them identify and correct problems before they happen. The future of Industrial Scientific is shaped by a vision of "eliminating death in the workplace by the end of this century." With a solid track record of innovation, the company is well on its way to achieving that vision.

† Watlow is the largest custom designer and manufacturer of industrial electric heaters, sensors, and controllers; with offices and manufacturing facilities around the world. The company brings its thermal expertise to numerous applications, including photovoltaic, semiconductor, analytical instrumentation, medical equipment, plastics processing, foodservice equipment, packaging, aerospace, and others.

‡ Tom Lyons, continuous-improvement manager at Watlow's Hannibal and St. Louis manufacturing sites says that their Lean efforts have paid off in reducing the typical manufacturing process for a product to three to five days, compared to the previous 15 days.

At many of our client sites, both in the manufacturing and administrative areas, are Lean measurement systems that measure four principal metrics—safety, quality, delivery, and cost. Once a Kaizen event occurs, Lean metrics are used to measure team results on a daily basis and identify where gaps are occurring against goals. Then the team is allocated time each day to discuss the chief gaps for each category and work on solutions. Thus, the Kaizen events and the ensuing attention to these key metrics drive sustainable activity and improvements. The daily cell reviews are rolled up into a weekly review that looks at operational and financial performance of the facility and these results are provided to the corporate level.

Some of our clients also use Hoshin planning, or policy deployment, to ensure that tactical execution is linked to the strategic direction of the company, along with other metrics used in engagement of the employee population in rapid-improvement events.* One client plant averages about 30 events a year. Of its 300 employees, 90% have been involved in at least one event, and 60% have participated in two events. The more the population is engaged, the more they are going to understand and the better the improvement results are. Randy Fry, president and CEO of Photo Etch, an aerospace manufacturing company based in Fort Worth, TX, is such a strong proponent of Lean that he joined the board of the Supplier Excellence Alliance (SEA), a nonprofit group dedicated to promoting Lean enterprises, and speaks around the country on the topic. Fry said SEA provided the guidance and system that helped him implement Lean in a comprehensive fashion in his company.

Policy Deployment Model

How can a company properly plan, measure, and execute a Lean management strategy? Today's best model, like many of the tools of today's Lean businesses, originated in Japan as a mechanism to align the resources of a company to its most critical tasks. This model, Hoshin Kanri, is better known in American circles as policy deployment or strategy deployment. In terms of its specific functions, policy deployment

* Lean policy deployment makes you take a very good look at the organization of your company—what are your goals? And what concrete steps are we going to take to reach those goals? Using the principles of Lean manufacturing, the process takes you through how to plan for the success of your company by setting goals that stretch you beyond your comfort zone and providing you tools to find solutions to reaching your initiatives. In the past 15 years that we have helped clients get their programs up and running, we have seen enormous progress in many areas, including those that seemed insurmountable or had been placed on the back burner in the past.

- Guides executive management in the process of creating a shared vision
- Helps executives understand how current or new customers fit in that vision
- Focuses on the current, emerging, and strategic pressing needs of those customers
- Guides the company in the best use of its resources to meet those needs
- Ensures that company resources have the tools needed to turn the plan into reality

Under a policy deployment system, a strategic plan driven solely by the voice of the customer (VOC) is cascaded to the point of impact, where the work gets done. Specific objectives are developed that help determine what is considered a breakthrough in the customer's eyes. Tools such as bowling charts are used at least on a monthly basis to make sure the plan is on track and to facilitate regular adjustments to the plan. By following this framework, clients remind themselves on a continuous basis of the customer's critical to satisfaction elements.*

Ensuring Success of the Model in a Lean Environment

To ensure successful execution of the policy deployment model, the company must concentrate on several key factors. They are the following:

1. *Capture the true VOC:* This is not the voice of the marketing director, nor the voice of the vice president of sales. The true VOC is the data that reflects exactly what the customer values in terms of the products and services offered or not offered by the company. Collection of this data is accomplished in many ways such as through surveys, warranty, or return data or focus groups. No matter how it is

* For a worthwhile description of the details of the implementation process, see *Policy Deployment & Lean Implementation Planning: 10 Step Roadmap to Successful Policy Deployment Using Lean as a System* by Vince Fayad and Larry Rubrich. There are many books out there on the techniques of Lean and policy deployment, but this one is a great workbook that explains in simple language what you do, and where the pitfalls are. Even better, the authors were there, and are able to provide both the tools to do the job and have provided a light read that really is useful. Having worked with the authors personally, we can tell you that their method for policy deployment is among the very best. The processes discussed in the book allow company decision makers to set clear, attainable goals that every employee can understand and contribute to achieving. The book is written in a clear, easy to follow step-by-step process method and its use among our client organizations, coupled with our Lean deployment model, has allowed them to achieve millions of dollars in savings during the first years that they employed the process.

collected, it must be direct, unbiased feedback from the customer. There is no room for internal massaging of the raw information to influence the strategic plan.

2. *Policy deployment is all about focus:* It originated as a tool to assist companies with the alignment of resources to bring about the most important objectives. Associates must realize that to function in a policy deployment environment, they will give up many of their former duties in favor of those that bring about the company's objectives. This can create some sense of uneasiness or even fear because standard practices are challenged and, in many cases, changed. Meanwhile, the company must recognize that associates are now responsible for new tasks and need the tools and training to perform these new duties effectively and efficiently.
3. *Objectives deployment that are time based:* It is important to determine breakthrough objectives on a sliding scale relative to time. Breakthrough objectives typically cover a time frame of 3–5 years. In today's global trade environment with the competition it fosters, what is considered breakthrough today will represent standard practice in as little as 3 years. Therefore, companies must understand technological and market trends to anticipate the level of a true breakthrough in the years to come. Companies that are unable to make this distinction will congratulate themselves 3 years later for achieving mediocrity. Achievement of a breakthrough objective implies that a breakthrough has occurred. At the time a company sets the objective, the method for achieving it is not known. Working toward its achievement allows the company to discover innovative ways to meet customer needs, creating a best-in-class environment.
4. *Linkage of measures to the work unit (Gemba):* To maximize the policy deployment process, cascade the strategic objectives all the way through the organization to the point of impact, where the work gets done. A strategic objective to achieve a 150% improvement in productivity for an entire company during a 3-year period might mean a 100% improvement for Plant A, which translates into a 150% improvement for the ABC department and a 75% improvement for the XYZ department. Breaking the objective into specific pieces associated with each point of impact allows the entire company to strive for success, a more sustainable and efficient way to attain global achievement of the objective. Failure to cascade the plan to the point of impact will focus the strategy solely on the formulation

process, hindering the organization's ability to successfully execute the plan.

5. *Include other initiatives:* Many companies find that implementing policy deployment alone is not enough, particularly those that have an unsuccessful history of problem solving. Inclusion of other initiatives, such as self-directed work teams, as part of the policy deployment initiative can assist in the culture change required to truly achieve a breakthrough. Companies must carefully consider the strategic goal. In cases where the company must develop ownership of its workforce in better delivering against customer needs, a combination of policy deployment with self-directed work teams is typically a more successful approach than using policy deployment alone.
6. *Keep number of objectives to a minimum:* Some of the best policy deployment-driven companies in the world select only three breakthrough objectives for their strategic plan. A company new to policy deployment would do well to limit the number of objectives, thereby avoiding overstretching the company's resources and its ability to successfully implement breakthrough changes.

Technical Aspects of Lean Measures

Evaluate Lean metrics using the following criteria and core your answers according to the extent to which you agree with these statement as to how well the measures perform. Each Lean measure should (1) provide information that helps to manage customer service, quality, or performance costs; (2) add to the user's knowledge base; (3) add to the user's understanding of the process; (4) provide information concerning the sources of problems; and (5) provide information that is relevant to the decision in question. These factors contribute to customer value. Employees evaluate whether the measure adds to the user's knowledge base and/or adds to the user's understanding of the process. An understanding of the business's internal processes contributes to an understanding of the value stream. Employees also assess whether the measure provides information concerning the sources of problems or information that is relevant to the decision in question. This type of information assists empowered value-stream employees in making better decisions. Responses to this technical attributes section are then averaged, and an average close to five implies the measure contributes to Lean process understanding and is relevant to decisions made by empowered employees.

Behavioral Attributes Associated with Lean Measures

Behavioral attributes refer to whether management accounting measures motivate employee actions that are consistent with strategic objectives. Whoever first used the old adage "You get what you measure" certainly had this attribute in mind. Employees pay attention to measures and refocus their efforts to activities accordingly. For example, measuring the percent of defective parts motivates a purchasing agent to select suppliers who have high-quality products even if it means a modest increase in cost. If the procurement manager announces that the company instead will more closely monitor the purchase-price variance, the likely effect would be for the purchasing agent to negotiate lower costs—perhaps at the expense of quality. The impact of measures on behaviors and decisions is even greater when tied to performance appraisals and incentives.* Questions related to employee accountability and control lead employees to contemplate how their empowerment affects the process and measures.

1. How does this measure relate to employee work or output (e.g., quality and throughput)?
2. How does this measure relate to the firm's strategic goals?
3. Where does the measure focus attention?
4. What behavior is the measure attempting to motivate (e.g., smooth flow)?
5. Does the measure motivate non-Lean behavior (e.g., fear of taking a Lean action because of the non-Lean belief, stereotypes, confusion, us vs. them attitude, low trust, negative thoughts, politics between functional departments, and biases)?
6. Does the measure reflect and motivate Lean behavior (e.g., trust, cooperation, listening, patience, observation of activities, discipline, honesty, balance, wisdom, and objectivity)?

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* The behavioral conditioning of the measures leads employees to contemplate how a particular measure motivates them to manage or change their behaviors and decisions consistent with Lean principles. The questions ask how the measure relates to employee work or output. If the measure relates to quality as defined by the customer, then employees will emphasize behaviors that maximize customer value. The employees identify what behavior the measure attempts to motivate and what behavior the measure actually motivates. For example, if the measure is inventory turnover, it motivates decisions that improve the flow and pull of inventory. If the measure is productivity, it motivates employees to turn out product even when there are no customer orders, which would be anti-Lean behavior that creates unnecessary inventory and eventually will hinder production flow.

7. What group behavior does the measure motivate (e.g., produce volume, investigate quality problems, and instill ownership and pride)?
8. What individual employee behavior does the measure motivate (e.g., signal for help, ridicule, or envy)?
9. Do the users of this measure understand its calculation, definition, and purpose? In other words is there a good operational definition and used description?
10. How well is the measurement goal communicated?
11. What is the reward for goal achievement?
12. Who is held accountable for this measure?
13. Do those employees held accountable for the measure have control over the factors affecting the measure?

The behavioral attributes refer to the ways that measurements affect behavior by making information visible. Measurement communicates importance and signals priorities. As a result, employees are motivated to manage their behavior and output to improve those measures.*

Cultural Attributes Associated with Lean Measures

Cultural attributes refer to the beliefs and values embedded in a measure, and measures are symbols that represent mind-sets held by members of organizations. For example, the customer-value mind-set will force a business to consider measures that evaluate quality, cost, and time through a customer-focused lens. The mind-set of a Lean enterprise's employees would not support a measure that encourages overproduction of inventory because it contradicts the flow-and-pull principle. Employees would, however, recognize the value of a measure that encourages efficient use of space (e.g., occupancy charge per square foot used) because they would quickly recognize that extra space as waste.

* It is critical that the measure relates in part, or in whole, to achieving strategic goals. They evaluate the measure's ability to motivate desired behavior. The employees also determine if the measure evaluates the performance of only those individuals who have control over the measure. Also, we need to ask if the calculation and expectations of the measure are communicated clearly. Employees have a tendency to attribute success to their own behavior and to attribute failure to environmental factors. This tendency is especially evident when the measures for evaluation have no relationship to the company's strategic goals or when the employees have little understanding and/or no control of the measure. When the average score for this section approaches five, it indicates that the measure influences employee behavior and decisions consistent with Lean principles.

The following nine questions motivate managers to link measures to Lean principles.* The employees identify how the measure reflects value as the customer defines it. The questions encourage staff and line personnel to think about how the measure relates to the entire value stream or to individual cells. In addition, the questions reveal the measure's ability to encourage Lean concepts, such as minimizing inventory or promoting continuous improvement. Employees are also asked about a measure's ability to eliminate waste and nonvalue-added activities.

1. How does this measure reflect the belief system of the company (e.g., fiscal prudence, Lean practices, and high quality)?
2. Does the measure encourage behavior that conflicts with ethical behavior?
3. How does this measure reflect value as defined from the customer's viewpoint?
4. Does this measure promote thinking about the entire value stream, or does it focus on an individual department/cell?
5. Does this measure encourage one-piece flow through the production cell?
6. Does this measure encourage minimizing inventory or building inventory?
7. Does this measure provide adequate information to the people making the decision (e.g., cell or value stream employees)?
8. Does this measure promote continuous improvement at the cell and/or value-stream level?
9. Does this measure promote the elimination of unnecessary steps and/or waste?

After contemplating these questions, ask your employees to assess if the measure fits with Lean enterprise beliefs and values; help them decide how well the measure generates information on process factors that affect customer value. Ask them to consider how well the measure provides information that promotes thinking about the process or value stream.

* Cultural attributes refer to the beliefs, values, and mind-sets imbedded in a measure. Measures are symbols that represent mind-sets held by members of organizations and unconsciously guide sustainable behavior without the need for punishment or rewards. Employees use their belief system to interpret the meaning of accounting measures and determine what actions should be taken. For example, an organization steeped in Lean practices would not be able to successfully introduce a measure that encouraged building excess inventory. The 12 questions consider the characteristics ingrained in a Lean enterprise.

And, finally, ask the employees to determine if the measure provides adequate information for making decisions. The resulting score indicates how well the measure reflects the beliefs, values, and mind-sets of the Lean organization.

Performance Measurement and Lean Production Processes

Successful deployment and management of the Lean production process involves a different set of performance measures and a supporting system. Maskell and Bagelly (2004) argue that the Lean production focuses primarily on the process-level performance measures such as customer takt time, flow rate, and stability of the pull system instead of the traditional measures such as machine-level utilization and overhead absorption. The performance goals around these measures are managed by providing visibility into the individual and task-level performance via visual management system. In addition, the impact of interdependent activities on the overall performance is not always logical, and hence the causal relationship between the tasks and activities is captured via combination of visual management, integrated measures, and frequent analysis of the individual and task-level measures. To enable coherent decision making, horizontally across the process and vertically among the managers and employees, the uniform sets of measures are used and the measurement information is collected into a single information source.

The process leads employees through a series of questions to stimulate their thinking about a measure's desired qualities and the information the measure provides. As a result, employees may identify redundancies in the measures. Streamlining the performance measurement set facilitates a more accurate and timely evaluation of performance. This process may also highlight the measure's limitations. By directing attention to the measure's characteristics and then assessing the measurement using consistent criteria, employees may realize the weaknesses in the measure from the calculation's accuracy, to the message it conveys to employees, to its consistency with the corporate mind-set. This knowledge facilitates improvements in measurement by revealing measures that need tweaking to be more consistent with the desired attributes.

A focus on the attributes underscores conflicts that arise among the measures. Although a balanced approach to performance measurement inherently involves situations where improvement in one measure is offset by performance in another, better understanding of these conflicts enables

employees to make more informed decisions about the trade-offs. This understanding also helps employees who are redesigning the performance measurement system. Although a total system revamping often is not feasible as the company transitions to Lean, the set of measures will need to be adjusted to promote Lean thinking. This process highlights measures that are not consistent with Lean and identifies gaps that exist in the current system. In some cases, this assessment process may provide a mechanism to communicate to top managers why there is a need to entirely rethink the performance measurement system.

Measurement Visibility

A Lean management process has a strong focus on direct reporting of measurements at the source, which in turn provides real-time visibility across the production process. It is common—and preferred—to see whiteboards located at production cells, measuring production rates and performance to schedule, and customer service level, such as on-time delivery, quality performance, safety performance, and set-up time trends (Carreira 2005). Richey (1996) observed that winners of the 1996 Shingo prize for manufacturing excellence primarily used a visual performance measurement system on the shop floor. Real-time visibility of performance measures across the production line enables operators to stay focused on their target, helps them understand how their work relates to the larger goals of the production line, and provides instant feedback for problems to be fixed quickly. For example, consider pull production practices described by Maskell and Baggely (2004).

Pull production is driven by customer demand, that is, a production process manufactures product only to meet precisely timed customer requirements. By allowing only a small amount of work-in-progress inventory to flow at any time, a pull system shortens the time that parts stay in the system by eliminating or greatly reducing waiting time. Thus, a visual presentation of the takt time—the rate at which a customer demands the product—along with the actual production rate, keeps operators focused across the production process, enabling them to meet customer demand. When actual production quantity falls below a certain level, operators raise the alarm by reporting the problem visually on the display or by turning on the *andon* light. This visual presentation of these measures helps operators up and down the production line moderate manufacturing tasks accordingly, and alerts managers and engineers on the shop floor to solve

the problem quickly. Thus, the performance measurement system provides visibility across the Lean production process, enabling it to meet customer demand with minimal waste of actions, time, and material.

Measurement Relationships

The assessment questions outlined in this chapter provide guidance and discussion points about each of your measures and their influence on employee behavior and organizational performance. Ultimately, many managers, after developing feasible reasons for the results, decide how to improve the measurement process and to have a follow-up exercise to evaluate what the organization should be measuring in line with its Lean culture. In some cases, the process may eliminate measures that are inconsistent with Lean thinking. Or it could lead to something as simple as modifying the measurement factors, such as the frequency of reporting, the format used to report and display the information, or the individual held responsible for the measure's outcome.

Many of the managers surveyed liked the three attributes: technical, behavioral, and cultural and they stated that the process makes them think about the measures in a different way—through a Lean lens. They also found it helpful to start with big-picture objectives and questions that are included in the assessment questions described in this chapter. These will be instrumental in evaluating your measurement system using the tools presented in the Measurement System Practice Section in this chapter. Managers also felt that these questions provided the context needed to evaluate the measures in line with Lean objectives. They noted that successful implementation of a Lean production process also depends on the causal relationships between actions and performance measures captured in the Lean measurement system.

For example, shop-floor employee involvement means first-level employees participate in activities to define and solve problems and can be the forerunner to all other Lean practices. Enhanced shop-floor employee problem solving skills facilitate reengineering of set ups, establishment of quality improvement efforts, and initiation of effective preventive maintenance programs (Koufteros et al. 1998). However, lack of employee involvement is very difficult to measure directly. Thus, the identification of root cause is determined via causal relationships established in the measurement system. At the shop floor, production performance measures are gathered for each cell very frequently (e.g., hourly) and presented visually

on the shop floor using storyboards.* (Richey 1996; Maskell and Baggaley 2004; Carreira 2005).

The first storyboards were originated in the Disney animation studios in the 1930s. According to Walt Disney, the storyboard was invented by Web Smith, an animator and one of the first story men at the studio. When Web planned a story, he would draw it instead of describing the action in words. At first he simply spread the drawings out over the floor of his office, but soon graduated to pinning them in order on to the walls. In this way, the unfolding story gains the valuable visual dimension. According to legend, Walt was none too happy with the innovation. He had just redecorated the offices and the marred walls in Web's office stuck out like a sore thumb. But Walt also recognized the order imposed by the posted drawings and the ease with which the entire feature could be analyzed and manipulated. So he ordered 4′ × 8′ corkboards and the storyboard was born.†

This performance measurement information serves two purposes. One is to provide real-time feedback to the operators and the other is to analyze the data for identifying consistent problems. If production measures fall short of the target consistently and problems are not reported by shop-floor employees, it is an indicator of insufficient employee involvement, in which case further action is taken to educate employees or enhance their morale to increase shop-floor employee involvement. The causal relationship between employee education, morale, and outcome is captured in performance measurement system. Similarly, equipment that has not been properly maintained may cause unplanned downtime that increases waiting time and induces firms to compensate for poor equipment reliability by adding inventory. Inventory extends throughput time by clogging the

* A storyboard provides a quick, visual summary of a team's work. They are very well suited as presentation materials to highlight the work of the project, the improvements made and for executive overviews. I recommend having a storyboard created before closing the project. The mind map technique can be used as a simple outline of a storyboard. Depending on your project, you may use a different set of tools but the storyboard outline can still serve as a guideline for what should be included. Also, organizations that have a mix of Scrum and Kanban teams can now manage agile projects in the same system. Teams practicing *Scrumban*, or Lean methods within iterations, can also use the storyboard to support their process. As agile teams adopt Lean principles, Kanban is a common practice used to help drive even higher levels of visibility and efficiency.

† Soon, every Disney cartoon for so lived on the storyboard, and the board themselves moved to new departments as the project progressed. The story men would pitch their ideas to Walt on storyboard, color, and sound were both added using the storyboard as reference point. When Walt hijacked the studios innovators to design the attractions for Disneyland, they brought the storyboard along with them. And today, it has evolved into a standard technique among the Imagineers.

factory floor (Koufteros et al. 1998; Cua et al. 2001). These casual relationships are captured in the performance measurement system by measuring operational equipment effectiveness, which is a function of down time, production rate, and first time throughput (Jeong and Phillips 2001).

Single Source of Measurement Information

In a Lean production process, engineers, managers, accountants, production and inventory planners, and floor supervisors use the information from a single performance measurement system. Use of a single performance measurement system allows coherent decision making and keeps activities focused toward the goals. In contrast, traditional reporting logic usually yields a report only after a week or more has elapsed after the fact. Further, it is all too often delivered in a sufficiently complex format such that fairly complicated analyses are required to translate the information to render it viable, let alone relevant. In sum, traditional reporting logic essentially delivers for the most part *old news*. To avoid the time lag between reporting and action, managers and supervisors responsible for the production process instead should use a visual management system in real-time by walking down the production line.

The successful deployment of the Lean practices across the production process incorporates a systematic performance measurement and support system. To synchronize the tasks and activities within the limited focus of the production process, the performance measurement system encompassed all three attributes described above. Although a systematic and structured approach is adopted to deploy Lean practices and the corresponding performance measurement system, the impact of Lean practices on the overall enterprise performance remains limited because of the restricted focus on the production process. Realizing the limitations of the Lean production process, researches and practitioners further developed the Lean philosophy into broader approaches called system change initiatives.

In the Section Measurement Systems Practice we will describe how your organization can put to practical use the technical, behavioral, and cultural attributes of Lean measures described in this section. This measurement system in practice sections describes the fundamental tools required for you to transition from traditional measurement system to a Lean measurements system.

MEASUREMENT SYSTEMS PRACTICE

Why Measure

As discussed in the theory section of this chapter, there are almost as many schools of thought on measures as there are measures. There are those that believe that you should "only measure what you want to improve." There are those that believe that "what gets measured gets done." Some organizations talk that their customers come first only to set up measurements that are all internally focused on their business and consider the customer only as an afterthought. Still others tout that their employees are their *most valued asset* yet they have limited education programs to increase an employee's capacity to add value for the customer. Most of the employee-related measurements systems in practice today indicate that employees are viewed in many instances as liabilities not assets.

These observations only solidify our premise stated in previous chapters; "measures drive behavior and non-lean measures drive non-lean behavior." Poor measures are one of the fundamental reasons why many Lean implementations fail.* Organizations try to use Lean tools to improve processes while holding on to non-Lean measurement systems based on traditional beliefs discussed in Chapter 5. This is common practice observed across many industries and the fundamental reasoning behind the authors structuring of this handbook.

Ultimately, the primary objectives of measures should be to gage your organizations response to what a customer wants. They should be easy to understand and visible to all employees. They should show the connection between individual efforts and the measure; and how the measure is improving performance for the customer. They should show individual efforts are tied to department of functional efforts, which result in organizational performance. This approach answers some of the most common and important employee questions regarding measurement; how am I doing? How are my efforts influencing my functional area? Finally, how are those efforts helping the organization?

* Rubrich, Larry; *How to Prevent Lean Implementation Failures.*

TYPES OF MEASURES

There are a number of different types of measures that are used in different situations across your organization. The following sections briefly define the most common types of measures and how/where they are used.

Diagnostic measures: They are set up to diagnose the extent of a problem. They are usually defined when a process output is not what was desired or anticipated. They are often used in Kaizen process trouble shooting or Morning Market product or process failure analysis. They diagnose possible reasons for why something undesirable occurred and help to develop an understanding of process deficiencies or to establish some technical process data on which a course of action to improve the situation can be based.

Baseline measures: Measures that establish where you are. Sometimes these are used to establish an initial assessment of where a process—service delivery, piece of equipment, or other activity—is performing. Baseline measures that pass the "is it a Lean Measure" test can become part of your permanent Lean measurement system.

Trend measures: Measures that monitor activities or performance indicators over time. They are compared to baseline measures to provide guidance employee action, if necessary. Typical trend measures are process measures.

Control measures: Similar to trend measures with the added caveat that they are put on critical processes that must be addressed if their performance strays out of predefined limits.

Family measures: A group of measures that can be used to collectively describe an area of performance. Care should be taken when using a group of measures that they are all Lean in nature and that they do not conflict with other company measures.

Output measures: These are measures that monitor the value add of any given process in the value stream. They represent what one process step has produced for the next process step. When we begin to take a closer look at measures, we find that most measures created by management are output measures.

Input measures: These include typical process inputs of raw materials, equipment, manpower, and methods. Their definition influences how the organization will produce value for the customer. Unfortunately,

most inputs are not measured at all, or are measured improperly, rather they are selected based on a traditional belief. For example, manpower is selected based on headcount (internal focus) not what labor component is required to perform for the customer (external focus).

Often, organizations have too many output measures and too few input measures. The difficulty with this is that it is the *input measures that dictate results*; not output measures. The trap is organizations want results and define output measures; when functional areas fall short of expectations, management places blame on individuals or departments rather than addressing true process deficiencies or input restrictions that produced the undesired results in the first place. Bad outputs are always the resultant of bad inputs; and *most bad inputs come from bad belief systems.*

Again, this is why we put so much emphasis on beliefs, education, and change management in this handbook. To become a Lean organization driven by Lean measures; your organizational belief structure has to be converted to a Lean belief structure.

MEASURES AND THE SUPPLIER–CUSTOMER RELATIONSHIP

Most observed wastes results from inadequate understanding of the string of supplier customer connections across your value chain. To achieve 100% value creation for the customer, supplier output from one process step must be exactly what the customer input requirements are for the next process step. In essence every process step in the organization is both customer for the previous process step and supplier for the next process step. In many cases, supplier (these can be either internal or external suppliers) outputs are not equal to required inputs of the next process step customer (Figure 8.1).

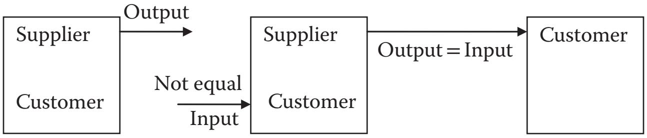

FIGURE 8.1
Matching supplier outputs to customer inputs.

LEAN MEASURES VERSUS NON-LEAN MEASURES

Separating Lean from non-Lean measures is a very difficult task. It raises numerous questions. How do we prove that a measure is non-Lean or Lean? But what makes a measure good or bad? Does the measure inherently contribute to waste? Does the measure cause the employee to make a decision that is detrimental to productivity or profitability? Does the measure initiate waste where it is or in an adjacent area? Does the measure promote performance from the customer stand point?

How many measures do we need? To provide guidance on measurement identification and selection for your Lean measurement system, you must begin to understand the difference between the attributes of traditional measures and Lean measures.

Table 8.1 shows six fundamental Lean versus traditional measure attributes or characteristics. The table shows in a point–counterpoint manner, the focus or importance that management places on their business, customer, or employee. In traditional organizations the voice of the business (VOB) is much louder and more prominent than the VOC or the voice of the employee (VOE). In the Lean organization, the sequence would be VOC, then VOE, and finally VOB. This hierarchy has been proven across many industries to produce the highest levels of productivity and profitability.

HOW LEAN IS YOUR CURRENT MEASUREMENT SYSTEM?

Six fundamental questions concerning your current measurements can assist you when assessing how Lean your current measurement system is. These are based on Table 8.1: Traditional versus Lean Measures Characteristic Attributes. When reviewing your current measurement system ask the following questions about each measure. If you answer no to any of these six questions, the measure may be target for modification or elimination.

1. Is the measure externally focused on the customer (i.e., either internal or external customer)?
2. Is the measure based on a Lean philosophy or belief?

TABLE 8.1

Traditional versus Lean Measures Characteristic Attributes

Traditional Measures	Lean Measures
Internal focus (business)—these take many shapes and include	External focus (customer)
Conflict with customer requirements	Measures based on Lean philosophy or direct customer requirements
Reactive measures setup based on and to react to poor financial statement performance	Proactive—set measures and behaviors to achieve desired outcomes. Include only socio-technical, educational, change management and Lean performance measures
Too many measures and primary focus on *output measures*	Considers only business driving measures that meet Lean management and Lean qualifiers Primary focus on *input measures* required to achieve customer requirements
Measures *vertically aligned* through *functional departments*. These measures can be costs, staffing, budgeting, consumable expenses, capital expenses; all can hinder performance delivery for the customer	Measures are *horizontally aligned* across the value stream to measure the long series of *supplier–customer connections*. These define proactive steps required for your success at delivering value to the customer. Costing, productivity, and profitability are measured as value is delivered
Tactical measures are *not connected* to strategic measures	Activity Level 1 roll to tactical Level 2 rolls to strategic Level 3. *All measures must roll up* or are complimentary to the set of strategic measures Level 3

3. Is it a proactive measure designed to achieve specific results?
4. Is it an input or output measure?
5. Is the measure horizontally aligned across the value stream?
6. Does the measure effectively roll up from activity level to functional area level and finally to the organization level?

CRITICAL COMPONENTS OF THE LEAN MEASUREMENT SYSTEM

After an initial assessment your next step is to establish a Lean measurement system within your current organizational structure. A Lean measurement selections guide consists of six components that will enable you

to begin to develop your own Lean measurement system by modifying and transitioning your current system into a Lean system.

Traditional organization functional areas: First look at each functional area and begin by selecting the measures in that area. Are they Lean? Do they pass the six assessment questions? If not, they should be modified to fit the measure roll-up pyramid (Figure 8.2).

Lean management measurement areas: Your Lean management system should have measures that encompass the four main Lean management areas, socio-technical, educational, change management, and Lean performance. We are recommending that you start with one socio-technical measure, one educational measure, one to three change management measures, and three to six Lean performance measures. These are high-level measures that are basically strategic measures—Level 3.

Lean measurement qualifiers: Each of the Lean management measures must meet one of the Lean performance qualifiers.

Time: Although there are instances that the delivery of a product or service in not time dependent, the vast majority of customers have some time requirements. The question for you is how you structure your internal measures to achieve customer time expectations. Time measures typically revolve around; cycle time, lead time, or on-time delivery. Be careful to clearly understand customer time requirements and how they interact with internal processes. Many organizations introduce significant waste into the organization resulting from poorly understood timing requirements.

Quality: There can be many aspects that define quality. Develop a clear understanding of customer requirements. In many instances, this encompasses not only knowing what the customer wants but also what they do not want. Accurately define and describe quality measures using operational definitions wherever you can.

Customer value: Do you have a documented and well-defined description of customer value for each product or service? Does your measurement system completely cover customer value expectations? Many organizations have disconnects between what the customer wants and their ability to deliver value. Customer value measures may not be easy to see and require that

your organization do detailed discovery with the customer to keep up-to-date on changing customer needs. Set your measures accordingly.

Customer feedback: You must have measures that are tied to your customers with direct feedback. Feedback should be quick, quantified, and provide quality data that are actionable by your employees. If you are not currently providing 100% first-pass product quality to your customer, you need to develop a customer feedback measurement.

Employee behavior: Measuring Lean employee behavior is more qualitative than quantitative. This measurement can be partially built into the employee review process; but also should be exposed as daily positive examples of true Lean behaviors.

Education: Measurements must be ongoing in the area of Lean education. First an employee participation measure can be used to document the extent of Lean education participation. The results from the application of Lean by individual employees, Lean project teams, and Lean trouble shooting activities displayed around the organization will provide evidence that a Lean learning environment is present.

Change management: Measuring change management should be focused on continuous improvement activities. Measure employee participation in active Kaizen deployment projects across the company. Every department or functional area should have a change management measure. The objective with change management is to engage employee participation. Your measure should reflect this objective.

Strategic measures—Level 3 (organizational): Most companies tend to have too many measures without knowing the dependency of each on each other or the conflicts that arise from trying to achieve measures that are at cross odds with each other. For this reason, it is best to start with a small number of truly Lean measures at the strategic level; measures that allow department-level and activity-level measures that readily roll up to the strategic measure (Figure 8.2).

Four examples of Lean roll up measures are the following:

1. 100% Employee Lean behavior—socio-technical
2. 100% Employee participation—education

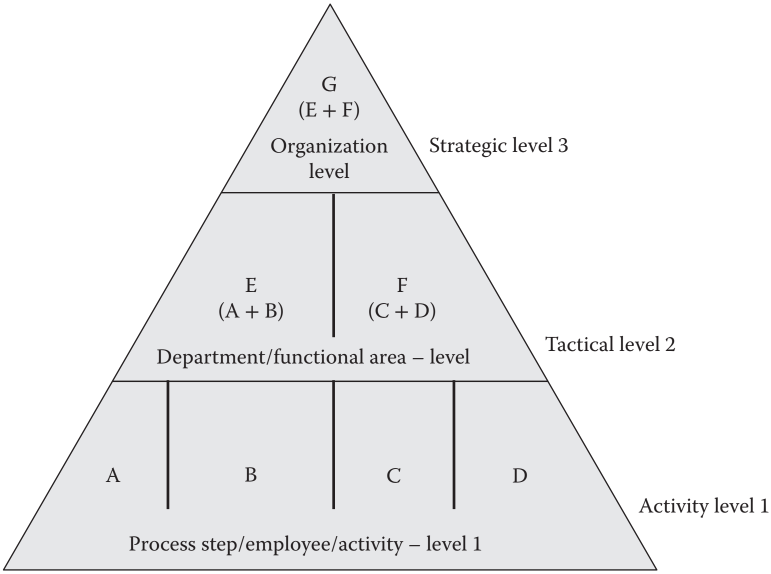

FIGURE 8.2
Measure roll-up.

3. 100% Kaizen participation—change management: Three Kaizen measures could include (1) number of employees participating in Kaizen and You projects, (2) number of employees participating in Kaizen teams projects, and (3) number of employees conducting Kaizen Trouble Shooting projects.
4. 100% Customer satisfaction—three to six measures could include (1) lead time, (2) manufactured cost/piece, (3) 100% first-pass quality, or (4) 100% service compliance.

Tactical measures—Level 2 (department or functional area): These measures are defined based on the strategic measure and basically data collection, reporting, and managing. To begin aligning your Lean measurement system, each traditional organization department should be measured based on same Lean management system. Each department should have the same socio-technical, educational, and change management measures. Lean performance measures could be the same or vary by department. However, wherever possible, Lean performance measures should be selected that can be rolled up horizontally across the value stream to strategic measures.

Let us say that you have established that *lead time* was a critical customer requirement. Lead time could then be used as a measure literally across the company. In the case, you need to look at every department or individual employee that touches any activity that contributes to the time from first customer contact with your organization until they receive your product or service. If you were to develop a Lean time chart using this approach, all employees can see their respective contribution to lead time from the customer viewpoint. With this common measure, you are now positioned to conduct company-wide process improvement programs with the sole unified company focus on lead time reduction.

Activity measures—Level 1 (process step): These are process step measures that typically are at the employee activity level. To continue with the lead time example, each component of each process step, that means each employee activity can be focused on reducing the lead time component of that activity.

SELECTING NEW LEAN MEASURES

You cannot have a good Lean performance measurement system without a good measure selection process. In Section How Lean Is Your Current Measurement System, we discussed the six key questions to ask when assessing your current measures. These questions are also used when developing new measures. The following seven-step approach will help you develop a good Lean performance measure. These are

1. Lean measure identification (What are you going to measure? Does it fit the six keys of Lean measures?)
2. Lean measurement system definition (How are you going to measure it?)
3. Lean baseline measurement (How are we currently performing to this new measure?)
4. Data collection (How can we gather data accurately and consistently?)
5. Data analysis (Will the data be self-explanatory (preferred) or how will data analysis be conducted, by whom and who decides what the data means?)
6. Performance measure communication (How will we systematically share data across the company?)

7. Action initiator (What are the signals for action when the data is undesired?)

By completing this seven-step process you will be able to develop documentation to address both the six keys to a good Lean measure and each of the seven steps to develop and implement that measure. Considerations such as definitions, forms, data collection plans, data analysis, charting, and reporting will all need to be considered when developing new Lean measures.

MEASURING PERFORMANCE OVER TIME

A good measurement system is the fundamental communication and management tool for performance and performance improvement from the customer standpoint. The two keys to effective performance measurement over time are (1) a standardized measurement collection system and (2) standardized measurement distribution and management system.

Establishing simple tables for all Lean measurements will assist in managing organizational performance for each measure. Figure 8.3 shows a sample for order processing lead time. This example is not comprehensive in nature. For order processing, times are measured at each process step

Performance Measure	Location or Process Step	Collection Method	Collection Frequency	Distribution Method	Distribution Timing
Order Processing Lead Time	Order Entry	Order Time Stamp	Hourly	Intranet Dashboard & Visual Management	Daily Visual Management Displays
	Accounting	Order time Stamps	Hourly	Intranet Dashboard & Visual Management	Daily Visual Management Displays
	Production	Order Time Stamps	Daily	Intranet Dashboard & Visual Management	Daily Visual Management Displays
	Distribution	Order Time Stamp	Hourly	Intranet Dashboard & Visual Management	Daily Visual Management Displays

FIGURE 8.3
Sustaining Lean measures.

for every activity from the moment a customer contacts the organizations until they receive their product or service. The following category descriptions will assist in the development of sustaining Lean measures:

Performance measure: A measure is typically only classified as a performance measure if it is tied to performance from the customer standpoint. These do not include dead cost measures such as raw material costs or direct labor costs. Performance measures should pass the seven attributes of a Lean measure.

Location or process step: This defines what functional area or process the measure is monitoring. It could also refer to the process step that the measure is generating information about. Some organizations refer to a specific employee or user of the information. However, we believe that it is better to focus on the process step independent of employee. If the performance measure is collected across several process steps then define each step in this section as shown in Figure 8.3.

Collection method: You must develop a clear definition of how the data is going to be collected. It should describe any instrumentation required, specifications limits, or calibrations. It should also describe how to take data readings; observations; data logging activities; and readings from gages, dials, clocks, or computers.

Collection frequency: When developing a measure you must specify how frequently data will be collected at each process step. This could vary depending on departmental or process steps. The example of Figure 8.3 has collection frequencies of hourly and daily.

Distribution method: The object of defining a distribution method is to get all roll-up data for key performance indicators to all employees. For each measure specify how the measurement will be distributed or communicated across the organization. Possible communications outlets are internet, intranet, web portals, visual management systems, computer dash boards, and simple visual controls. The method will depend on who gets the data. Each measure may require several forms of communication to be effective.

Distribution timing: Finally you should define the distribution timing; that is, who gets what measures when. This is often critical when trying to meet customer demand. Front line employees may use visual controls that give real-time data on the measure while managers may get hourly or daily reports on the measure. Still others may only get weekly or monthly information updates.

Another important aspect of distribution timing is developing accelerated reporting for out of specification measures. For example, out of specification product may sound an alarm or other visual or auditory signal that prompts immediate response by a trouble shooting team.

SUMMARY

In the late 1980s, Lean thinking further matured into operations management and system-change initiatives, extending the scope and complexity of deploying and managing Lean practices. The most widely accepted system-change initiatives are TQM, JIT, Six Sigma, and business process reengineering (Bozdogan 2004). The scope of system-change initiatives extends beyond the production line, moving across functional boundaries and organizations to include suppliers and customers. System-change initiatives are deployed across multiple subsystems of the enterprise to achieve one or more of the following strategic objectives: improve quality, improve speed, reduce cost, and increase flexibility. Each initiative includes several different approaches to achieve these objectives.

Many of our clients surveyed envision significant changes in their metrics concerning production. The measurement process outlined in this chapter clearly indicated to them that current metrics were not connected to having a Lean fulfillment system. When asked what metrics they expected to be using in another year, they replied that they expect to have safety, quality (First-pass Yield as an example), and customer service as their primary macro-metrics.

When is a good time to implement Lean measurements? If times are bad and you are in a recession, you need to implement Lean metrics now to handle the increased work resulting from internal layoffs. But Lean as a strategy also means being more efficient when times are good to increase your competitive advantage. When can you stop becoming Lean? Lean helps an organization release unnecessary capacity, which we call waste. Just like a diet program is designed to reduce fat from your body, you must also measure the weight loss to be truly effective. Fat is just extra calories or stored energy your body is not using, which is also wasted energy. In business, this wasted energy has many forms: inventory, rework, defects, inspection, overproduction, unnecessary motion, delays, overprocessing, and unnecessary transportation. Lean thinking is like a diet program designed to eliminate this waste.

In bad times, you may be forced to do less and as a result you can use Lean measurements to adjust to the recession. But it is the good times that are more likely to cause your business to gain weight. When times are good, it is just too easy to add people, begin unnecessary work, build inventory, and absorb unnecessary transportation. It is during the good times that implementing Lean measurement methods is needed even more. So in bad times you need to implement Lean to survive the recession and in good times you need a Lean competitive advantage. When can you stop becoming Lean? We believe your organization can always use Lean. Just like a diet program requires you to measure your weight loss and change your eating habits, forever, you can never stop being Lean either.

In your Lean measurement system, be sure to include measures for socio-technical, educational, and change management areas as they are fundamental requirements of developing a Lean environment. Several 100% measures were identified as starting points for your Lean measurement system. These include 100% employee participation, 100% employee Lean behavior, 100% customer satisfaction, and 100% Kaizen participation. These following four points should help you prepare effective Lean measurement system:

1. Assure that your new measures meet the six key attributes of a Lean measurement.
2. Create several types of measures that are required to achieve a Lean measurement system: diagnostic, family, input, output, trend, and control measures.
3. Try to avoid the common mistake of too many output measures and too few input measures. Be sure to include adequate input measures; they are the primary drivers of output performance measures.
4. Create a sustaining Lean measures chart for each measure in your organization.

Our hope is that the focus on productivity alone will diminish as processes are streamlined and more directly connected to customer demand. In fact, during the past 5 years or so, as a result of the assessment process, many managers felt that even though they had made significant progress toward Lean processes, they still needed improvement in one very critical area—rethinking their metrics to encourage superior Lean behaviors and decisions.

9

Lean Concepts, Tools, and Methods

Management's reliance solely on Lean Six Sigma Tools for organizational performance improvement is fool's gold! Lean Six Sigma Tools are not the answer; they are the instrument used to apply Lean Six Sigma Concepts.

Learn the Concepts…. Apply the Tools…. Get the Results.

Richard Charron

OVERVIEW

Both Lean concepts and Lean tools are an integral part of Lean Six Sigma (LSS) process improvement projects. Contrary to popular belief, Lean tools alone will not provide the results that are often attributed to Lean implementation programs. Several Lean concepts, when taken together, form a Lean operational philosophy, which is a primary requirement for successful Lean programs. In this chapter we present some basic Lean management concepts and then the most common Lean tools (Table 9.1). When we apply Lean tools in pursuit of these concepts, a Lean organization emerges. If we endeavor to apply Lean tools in the absence of these Lean management concepts, process improvement projects often fall short of desired improvement expectations.

$$\text{LSS concepts} + \text{LSS tools} = \text{Performance improvement}$$

TABLE 9.1

Glossary of Lean Concepts and Tools

Lean Concepts	Just the Facts
Waste	Anything in your processes that your customer is unwilling to pay for—extra space, time, materials quality issues, and so forth.
VA	All activities that create value for the external customer.
NVA	All activities that create no value for the external customer.
BVA	Activities that do not create value to the external customer, but are required to maintain your business operations.
Waste identification	The primary fundamental Lean concept is the ability to see waste in your organization. This encompasses being able to readily identify the nine wastes and consistently manage to avoid these occurrences. More importantly, from a management standpoint, it means possessing the ability to proactively lead and mentor employees to conduct waste-free activities daily. To do this the Lean manager must master the concept of waste identification by understanding waste creation in all its forms.
Waste elimination	The ability to apply LSS concepts and tools to eliminate identified wastes. This entails continuous learning of how to apply concepts and tools either independently or in groups to achieve process improvement results.
Standard work	Standard work is a systematic way to complete VA activities. Having standard work activities is a fundamental requirement of LSS organizations.
Value stream	A conceptual path horizontally across your organization that encompasses the entire breadth of your external customer response activities. That is, anything that transpires from the time your organization realizes you have an external customer request until that external customer receives its product or service.
Value stream management	A systematic and standardized management approach using LSS concepts and tools. Value stream management results in an external customer-focused response to managing VA activities.
Continuous flow	The Holy Grail of manufacturing, often referred to as make one–move one. One-piece flow or continuous flow processing is a concept that means items are processed and moved directly from one processing step to the next, one piece at a time. One-piece flow helps to maximum use of resources, shorten lead times, and identify problems and communication between operations. During any process improvement activity, the first thing on your mind should be “Is what I’m about to do going to increase flow?” Achieving continuous flow typically requires the least amount of resources (materials, labor, facilities, and time) to add value for the customer. Achieving continuous flow has been credited with the highest levels of quality, productivity, and profitability.
Pull systems	Systems that only replenish materials consumed by external customer demand. These systems naturally guide purchasing and production activities, directing employees to only produce what the external customer is buying. The Kanban tool is used to achieve this Lean concept.

TABLE 9.1 (*Continued*)

Glossary of Lean Concepts and Tools

Lean Concepts	Just the Facts
Pull systems	Systems that only replenish materials consumed by external customer demand. These systems naturally guide purchasing and production activities, directing employees to only produce what the external customer is buying. The Kanban tool is used to achieve this Lean concept.
Quality at source	Building quality into value-adding processes as they are completed. This is in contrast to trying to *inspect in quality*, which only catches mistakes after they have been made. An effective quality at source campaign can minimize or eliminate much of the expense associated with traditional quality control or quality assurance programs.
Takt time	Takt time is the demand rate of your external customer for your products. It signifies how fast you have to make products to meet your customer demand. Once you calculate takt time, you can effectively set your VA processes to meet this customer demand. In essence, Takt time is used to pace lines in the production environments. Takt time is an essential component of cellular manufacturing.
JIT	A concept that espouses materials sourcing and consumption to meet external customer demand. Properly executed, it helps to eliminate several wastes, including excess inventory, waiting, motion, and transportation.
Kaizen	The Japanese term for improvement; continuing improvement involving everyone—managers and workers. In manufacturing Kaizen relates to finding and eliminating waste in machinery, labor, or production methods. Kaizen is a versatile and systematic approach to change + improve all processes. In virtually all LSS organizations, the concept of Kaizen is practiced by all employees at all levels of the organization.
Materials, machines, manpower, methods, and measurements (5Ms)	The five key process inputs. The pursuit of LSS is an exercise in the effective use of the 5Ms to achieve customer requirements and overall organization performance.
Lean accounting	A method of accounting that is aligned horizontally across your organization with the value stream. Traditional costing structures can be a significant obstacle to LSS deployment. A value stream costing methodology simplifies the accounting process to give everyone real information in a basic understandable format. By isolating all fixed costs along with direct labor we can easily apply manufacturing resources as a value per square footage used by a particular cell or value stream. This methodology of factoring gives a true picture of cellular consumption to VA throughput for each value stream company-wide. Now you can easily focus improvement Kaizen events where actual problems exist for faster calculated benefits and sustainability.

(*Continued*)

TABLE 9.1 (*Continued*)

Glossary of Lean Concepts and Tools

Lean Concepts	Just the Facts
Lean supply chain	The process of extending your LSS activities to your supply chain by partnering with suppliers to adopt one or more of the Lean concepts or tools.
Toyota Production System	The Toyota Production System is a technology of comprehensive production management. The basic idea of this system is to maintain a continuous flow of products in factories in order to flexibly adapt to demand changes. The realization of such production flow is called JIT production, which means producing only necessary units in a necessary quantity at a necessary time. As a result, the excess inventories and the excess workforce will be naturally diminished, thereby achieving the purposes of increased productivity and cost reduction.
5S	A methodology for organizing, cleaning, developing, and sustaining a productive work environment. Improved safety, ownership of work space, improved productivity, and improved maintenance are some of the benefits of the 5S program.
OEE	OEE is an effective tool to assess, control, and improve equipment availability, performance, and quality. This is especially important if there is a constraining piece of equipment.
Mistake (error) proofing	Mistake proofing is a structured approach to ensure a quality and error-free manufacturing environment. Error proofing assures that defects will never be passed to the next operation. This tool drives the organization toward the concept of quality at source.
Cellular manufacturing	A tool used to produce your product in the least amount of time using the least amount of resources. When applying the cellular manufacturing tool, you group products by value-adding process steps, assess the customer demand rate (takt time), and then configure the cell using LSS concepts and tools. This is a powerful tool to allow the use of many Lean concepts and tools together to achieve dramatic process improvements. (See cell example at the end of this chapter.)
Kanban	A Kanban is a *signal* for employees to take action. It can be a card with instructions of what product to make in what quantity, a cart that needs to be moved to a new location, or the absence of a cart that indicates that an action needs to be taken to replenish a product. This is a fundamental tool used to establish a *more continuous flow*. Kanban is a simple parts-movement system that depends on cards and boxes/containers to take parts from one workstation to another on a production line. The essence of the Kanban concept is that a supplier or the warehouse should only deliver components to the production line as and when they are needed, so that there is no storage in the production area. Kanban can also be effective in Lean supply chain management.

TABLE 9.1 (*Continued*)

Glossary of Lean Concepts and Tools

Lean Concepts	Just the Facts
	In document intensive environments (e.g., medical devices, biopharma, healthcare, and aviation industries) with government document management regulations such as Food and Drug Administration (FDA) or other federal agency, Kanban can be an effective tool to improve document flow by establishing which document to review or approve next.
VSM	A process mapping technique that consists of a current state map describing initial conditions of a process and a future state map that defines an improved process. The current state map typically includes some descriptions of the 5Ms that will be targets for modifications in the future state.
Visual controls	Visual controls are tools that tell employees *what to do next*, what actions are required. These often eliminate the need for complex standard operating procedures and promote continuous flow by eliminating conditions that would interrupt flow before it happens.
Single-minute exchange of dies (SMED) or quick changeover	SMED is an approach to reduce output and quality losses because of changeovers. Quick changeover is a technique to analyze and reduce resources needed for equipment setup, including exchange of tools and dies.
TPM	TPM is a maintenance program concept that brings maintenance into focus to minimize downtimes and maximize equipment usage. The goal of TPM is to avoid emergency repairs and keep unscheduled maintenance to a minimum. TPM programs are typically coupled with OEE activities, which identify where to focus your TPM activities.

In the early stages of your Lean journey, you should try to understand where you currently stand as an organization. Does the company have a strategic plan with high-level Lean measures that department and process-level measures roll up to? Does the organization have a Lean operational philosophy, starting at the executive management group, which flows down to the senior management group, department managers, and ultimately to associate employees? Does the organization understand the difference between the traditional organization and what it means to operate as a Lean organization?

In today's business world, Lean is for everyone. It is a true operational philosophy that, to produce real sustainable results, must be adopted

by employees at all levels of the organization. Also, a Lean operational philosophy can be used in just about any organization. Although Lean was originally defined and developed for the manufacturing community, today Lean or LSS initiatives can be found in almost every organization and every industry. For example, LSS is prominent in service organizations, manufacturing industries, government agencies, health-care, and nonprofit organizations. Of course, each of these industries requires that we take a different look at how we apply the tools—not that we will be using tools differently, but how we will be applying those tools differently given the type of industry that we are in and what we are trying to achieve in terms of process improvement.

Basically, there are two management philosophies used in most organizations today. The first uses a traditional approach, while the second uses a Lean, LSS, or world-class approach. Understanding your organization's current management philosophy goes a long way to helping you identifying which Lean concepts you may be lacking in and which Lean tools you want to apply within your organization. The remainder of this chapter presents an overview of both Lean concepts and Lean tools.

TRADITIONAL ORGANIZATION OPERATIONAL PHILOSOPHY

Traditional organization is a term we use to describe a set of operational philosophies, policies, and behaviors that drive all daily activities that occur within your organization. We use the term traditional organization as a reference point to more clearly define what it means to be a Lean organization. By describing both traditional (non-Lean) and Lean philosophy and beliefs, you will develop some idea of where your organization currently stands. What is your current organizational operational philosophy? What are your collective beliefs as both individuals and the organization as a whole?

Table 9.2 depicts some of the basic operational philosophies and beliefs of both traditional and Lean organizations. We present this in a point–counterpoint format to try and give readers a good description of where they currently stand and where they are trying to drive their organization to be.

TABLE 9.2

Traditional versus Lean Operational Philosophies

Traditional Organization	Lean Organization
Functional focus	Business focus
Management directs	Managers teach
Delegate	Support
Forecast driven	Customer driven
Fear of failure	Share success
Blame people	Improvement opportunities
Heroes and goats	Real teams
Us versus them	Community
Results focus	Process focus
Me (producer)	You (customer)
Dedicated equipment	Flexible equipment
Slow changeover	Quick changeover
Narrow skills	Multiskilled
Managers control	Workers control
Pure production environment	Learning environment
Supplier is enemy	Supplier is ally
Guard information	Share information
Customer as buyer	Customer as resource
Management by head count	Employees as needed
Volume lowers cost	Analyze cost drivers
Internal focus	External focus
Shallow process knowledge	Deep process knowledge
Quality problem detection	Quality problem prevention
Hierarchy	Flat organization
Short-term thinking	Balanced thinking
Worker accountability	Executive accountability
Rewards = money	Rewards = pride, then money
Competition	Cooperation
Complex	Simple

Table 9.2 identifies a number of traditional organizational beliefs and their corresponding Lean organizational beliefs. During the organizational transformation from traditional organization to a Lean organization, one of the primary objectives of the LSS practitioner is to identify these traditional operational beliefs, next use the tools and techniques described in this handbook to remove those beliefs from the organization, and finally replace those beliefs with the Lean beliefs shown in this table.

For example, let us discuss one of the traditional beliefs and then present the corresponding Lean belief. In this example, we will compare and contrast the concepts of *management by head count* and *employees as needed*. Often in traditional organizations, managers use a concept called management by head count. In this environment, the traditional manager only uses a very specific number of employees to complete certain components of the process that he/she is working with. What this means is that regardless of how many employees are needed to meet customer demand, the manager fixes the number of employees based upon another measure, usually labor dollars. This is done regardless of its impact on customer satisfaction or performance of the customer. Conversely, the Lean manager adds employees as needed to achieve the level of performance that the organization defined for the customer. In this environment, the Lean manager puts the voice of the customer first, and subsequently builds all of the required internal value-added (VA) activities to meet customer performance expectations.

The difference between these two concepts illustrates how easy it is for waste to be introduced into your operational processes when a management by head count philosophy is used. By using less than the number of employees that are required to meet customer performance, some or all of the traditional nine wastes are manifested in your organization. It is these operational wastes that drag down product quality, diminish employee productivity, and ultimately hinder company profitability. The impact that operational philosophy has on performance cannot be overstated. Everything we think, say, or do either creates value for the customer or creates waste.

LEAN OPERATIONAL PHILOSOPHY

A Lean operational philosophy is one that flows from an employee's basic fundamental understanding of Lean concepts and beliefs, and should be spread across your organization until it becomes a living, breathing, daily method of operation for all your employees. The Lean operational philosophy is literally for everyone. In many organizations today trying to implement Lean, it is often viewed as a set of tools for process improvement.

However, Lean is a true operational philosophy, and in order for your organization to become a Lean organization, the philosophy needs to be embraced at the highest levels of your company. C-level employees need to have an equal and thorough understanding of what it means to be a Lean organization in order for your company to effectively become one. Lean beliefs and behaviors need to be exhibited on a daily basis by executive management, department management, supervisors, and associates alike.

Lean is certainly for everyone. An organization aspiring to become a Lean organization must therefore have a master plan to involve 100% of their employees in the transformation process. The concept is discussed in further detail in Chapter 5.

LEAN MANAGEMENT CONCEPTS

To effectively select and apply LSS tools to any process, the management team must have a basic understanding of Lean concepts as the driving force for a Lean operational philosophy. In the absence of this Lean operational philosophy, the random selection of process improvement tools will not yield the desired results that management hopes to achieve from its process improvement programs. In the remainder of this section, we discuss the dominant Lean management concepts that fundamentally guide effective LSS process improvement programs in your organization.

Waste

What is waste? Waste is typically defined as any activity that your customer is unwilling to pay for. It is usually described in terms of VA activities versus no-value-added (NVA) activities (discussed later). Throughout the literature, you will find waste defined in terms of eight categories. These categories are overproduction, excess inventory, waiting, defects, extra processing, underutilized employees, motion, and transportation. All of our daily actions either add value from an external customer's standpoint or create one or more of these wastes in our operation.

The primary objective of the LSS practitioner is to learn how to identify where these wastes occur, how they occur, and what root causes led to the waste being manifested in your operation. Once we understand what these wastes are and how to identify them, we can use very specific Lean concepts and tools to eliminate these wastes permanently from our operations.

Value-Added Activities

A VA activity is basically any activity that the employee conducts that the external customer is willing to pay for. These activities are usually comprised as the process steps required to convert some raw materials into a modified and useful product for the customer. VA activities in service industries typically refer to any series of events that enhance an external customer experience or assist them with things that they could not ordinarily do alone. To decide whether an activity is VA or not, try putting yourself in the shoes of your external customer. If you can effectively say that your external customer would want to pay for the activity that you are about to conduct, then it is probably a VA activity.

No-Value-Added Activities

NVA activities are activities that do not contribute to meeting external customer requirements and could be eliminated without degrading the product or service function or the business, that is, inspecting parts, checking the accuracy of reports, reworking a unit, rewriting a report, and so forth. There are two kinds of NVA activities:

1. Activities that exist because the process is inadequately designed or the process is not functioning as designed. This includes movement, waiting, setting up for an activity, storing, and doing work over. These activities would be unnecessary to produce the output of the process, but occur because of poor process design. Such activities are often referred to as part of poor-quality cost.
2. Activities not required by the external customer or the process and activities that could be eliminated without affecting the output to the external customer, such as logging in a document.

It has been estimated that as much as 65% of all organizational activities and 95% of all lead time are consumed by employee NVA activities. This time

and energy is consumed by an almost endless series of things that we build into our processes that the external customer has no use for. If what you are about to do does not appear to be something that you would be willing to pay for as an external customer, then the activity should be questioned. Ultimately, all NVA activities should be targeted for elimination from your processes.

Business-Value-Added Activities

Since the 1980s, there has been dialogue concerning numerous activities that are NVA, but which are often required to deliver your product or service to your customer. We classify these as business-value-added (BVA). These could include a range of internal activities, such as accounting or order processing to external requirements that could include government regulations (e.g., Food and Drug Administration) or third-party stakeholders. In a pure Lean environment it could be argued that there are only two possible options for all activities: (1) VA activities (i.e., anything that is required to deliver your product or service for the customer) and (2) NVA activities (anything that is not required to deliver your product or service for the customer). Introducing terms such as BVA only serves to cloud the issue by promoting the concept that *some waste is allowable*. How you choose to categorize and quantify VA and NVA activities is up to your organization. In most organizations it would be a major mistake to classify certain activities as NVA, such as activities related to the following: safety, personnel, accounts receivable, accounts payable, processing, payroll, environmental, legal, taxes, marketing, and many more of the activities required to run the business. Communicating to the people in these key processes within the organization that their work is NVA would destroy morale throughout the organization. We agree that the amount of effort and money spent in these areas should be minimized and waste should be removed from these important business-required processes, but the organization has to be aware of the legal requirements that are imposed upon the organization and of the commitments it has to its internal customers and its other stakeholders. Without living up to these commitments, the organization would not be able to meet its external customer requirements and expectations.

Waste Identification

Waste identification is the ability to see something that others cannot. In Lean, we call this learning to see, a topic that was covered in detail in Chapter 3. It is not that Lean practitioners see any better or worse than we

do; it is that they see differently and are viewing the organization with a different set of beliefs and preconditions. Waste identification is an ongoing process in an LSS organization. We are constantly learning to see waste and understand how waste is manifested. Our view of how waste negatively impacts our product quality or performance from a customer standpoint changes forever once we begin learning to see.

This process of waste identification using both Lean concepts and Lean tools can be used in two ways. First, waste can be identified using qualitative techniques, which means using a technique that does not necessarily require that we measure anything. This is the primary fundamental strength of the Lean portion of LSS. An example of this qualitative method is identifying the waste from a Lean management concept, such as point of use storage (POUS) or quality of the source. For example, once we understand the Lean concept of POUS, we can readily see areas in our organization where the concept may be applied for materials, tools, instrumentation, paperwork, or other necessary components used in the VA process. More importantly, you begin to see the management philosophy that resulted in poor material storage to begin with.

Second, waste can be identified using quantitative data techniques. Quantitative techniques require that we use some form of measurement on a particular process to identify where the waste is occurring. This approach can be used on many waste identification activities, and it is a fundamental strength of the Six Sigma portion of LSS.

Waste Elimination

Once we have identified one or more of the wastes, we are in a position to begin to select Lean concepts or Lean tools to apply to that waste in order to eliminate it from our processes. At first glance, waste elimination appears to be a simple application of Lean tools in a given situation. However, it is not quite that easy. Much of the waste introduced into our organizational processes stems not from a simple flaw in the process itself; however, it stems from a management belief or operational philosophy regarding the control of all of our process inputs. As we will discuss later in this handbook, the key process inputs are materials, machinery, manpower, methods, and measurements. Our operational beliefs on managing these controlling-process inputs ultimately define how much waste there will be in our operation, where it will be located, what needs to be done to eliminate this waste, and what tools we will need to use to eliminate the wastes.

Developing a successful plan for waste elimination encompasses effective waste identification coupled with a Lean concept or tool selection and deployment. These activities are continuously conducted within the structure of a Lean management system where managers both support and encourage Lean practitioners to take the improvement actions.

There are three fundamental steps that must be followed to conduct a successful program using an LSS philosophy. These steps are so fundamental that each has been given its own chapter in this LSS handbook.

Value Stream

The value stream refers collectively to all those things required for your organization to produce perceived value for the customer. It includes materials, manpower, facilities, suppliers, or vendors; in essence, it includes everything that goes into creating an effective product or service that your customers are willing to pay for. The value stream contains all VA and NVA waste activities. A central activity for the Lean practitioner is to better understand all value stream components, both VA and NVA alike.

Visualizing the value stream is an integral complement of conducting any LSS process improvement program. There are several ways that a Lean practitioner can attempt to visualize the value stream. For example, to visualize a facility layout, the Lean practitioner can prepare a value stream map that identifies all the process steps, materials, equipment, facilities, employees, and activities required to add value for the customer. It can also include the measurements of time or output on those activities.

In a service industry environment, defining the value stream is equally important. For example, the value stream in a service industry is probably composed of a series of steps that need to be effectively taken by employees. They may or may not contain materials and equipment as is traditional with manufacturing operations. Much of the value stream can be composed of information management, documentation management, or activity management. Therefore, when trying to identify VA and NVA activities in the service environment, our challenge is to identify what activities need to be conducted, who needs to conduct those activities, and what accessories are required in order to provide a good service that the customer has defined.

When trying to define the value stream of a government agency or nonprofit organization, it can be even more complex than with the service industry organization or with the manufacturer. For example, nonprofit

organizations are typically restricted by what kind of activities they can conduct, and rarely have the resources associated with the service industry organization or a manufacturing facility. As a consequence, the identification process of the value stream may be more cumbersome and not quite as defined.

Government agencies can have even more complex value streams. Whether it is a county, state, or federal government agency, there can often be a significant number of stakeholders that all have an influence on the operation of the value stream. Each of these stakeholders may have a completely different view of what value is from their perspective. As a consequence, the challenge for the Lean practitioner in identifying the value stream, of which the activities are VA and NVA, and defining the process improvement projects to improve the value stream becomes more complex.

In these types of situations, it is often required that you break the value stream down into a number of connecting processes. In complex situations like this, whether at the service industry, government industry, or government agency, value stream management becomes a critical complement of any process improvement activity. Having said this, value stream identification and management have been effectively applied over the last several years in government agencies. For example, the Navy, Air Force, and Army LSS programs have been underway for the past 10 years. Having witnessed some of the significant cost reductions in these government agencies, the federal government is now considering trying to apply LSS to other federal government agencies.

Value Stream Management

Value stream management consists of a comprehensive approach to managing all aspects of value creation for the customer. A visual representation (value stream map(s)) of your entire value stream is created by identifying all activities required from the point that the customer initiates contact with your organization until the customer finally receives your product or service. This visual representation typically includes all the activities required for you to produce value from a customer standpoint. Throughout the visual representation the Lean practitioner endeavors to quantify how those activities are currently conducted in an effort to devise a methodology to improve those activities.

Consequently, how your organization defines your value stream is how you elect to develop partnerships and relationships with your vendors, the operational philosophy you have within your facility, and the methods with which you go about transferring your VA product or service to your customer, and how you measure performance; these are all defined as value stream management. An effective value stream management program, particularly for complex service industry organizations and government agencies or even simple manufacturing processes, typically requires the use of visual value stream mapping (VSM).

Continuous Flow

Establishing continuous flow is often not as easy as it might sound. The ultimate objective of establishing continuous flow is to link all of your VA steps seamlessly together, allowing no opportunities for downtime between steps. These steps could be automated manufacturing, manual assembly, general administrative tasks, warehousing, or shipping and distribution. In a service industry environment, the steps could include order processing, service delivery, interaction with the customer, or other VA activities.

Continuous flow has been referred to as the *Holy Grail* in manufacturing or service delivery. This is primarily because continuous flow refers to the state in which the VA entity flows from the point of inception to delivery to the customer. It is commonly accepted that once the organization achieves continuous flow, it achieves the highest level of product quality, productivity, and ultimately company profitability.

Continuous flow is important because once it has been established, it eliminates one of the primary wastes—the waste of waiting. Since up to 95% of all lead time can be waste, the importance of the concept of flow to reduce time to the customer cannot be overstated. The creation of flow eliminates the waste of waiting and ultimately decreases product cost.

Pull Systems

A pull system is one that is set up to respond directly to customer demand. The concept is that your organization will not expend any resources until a customer has placed demand on one or more of your VA products or services. For example, in a build-to-stock environment of a company that produces products A, B, and C, as the customer places orders and

these products are consumed from your finished goods inventory, your production facility begins to replenish these orders based upon this external customer demand.

Similarly, within your organization sequential process steps can be described as *suppliers* and *customers*. As one process step (customer) consumes materials from the previous process step (supplier) this signals the supplier to replenish those materials that have been consumed. This process flows back through your organization to your incoming raw materials. In a true pull system, all raw material purchases would be tied directly to customer demand. Pull systems work in conjunction with continuous flow to help organizations align all of their internal VA activities with customer expectations. Because this is such a powerful concept, some organizations start with focusing on only one thing—*making the product flow* at the demand of the customer.

Point of Use Storage

POUS is a term that we use to describe how we deal with our materials and tools that we use to add value for our customers. It is a concept that is exactly as it is described—POUS means putting those materials or tools where they are used by your value-adding employees. Applying this concept, we can eliminate a number of wastes or NVA activities. For example, if we have materials that we need for a particular step in a process located in a warehouse several hundred feet from where they are used, we need to use resources to move those materials to the point at which they are used. This adds cost to your product or service but no value from a customer standpoint. Moreover, in this example, a material that is located a great distance away from where it is actually used introduces the wastes of waiting, motion, transportation, and extra processing into our process, just to retrieve it and move it to the point at which we choose to create value for our customer. The concept of POUS is a very powerful waste identification and elimination concept. It can be used in almost every environment in some shape or form.

Quality at the Source

Most every organization today uses some form of quality program to assure acceptable product quality for the customer. Typically this requires inspections or reviews of product or service quality. Unfortunately, one

cannot inspect in quality; you can only identify that which you failed to make up to customer requirements. In the application of Lean concepts, we strive to achieve *quality of the source*, which is a term that is used to refer to producing quality at each individual VA step. The primary focus of quality at the source is to assure that we do not pass along a defect to the next step in a process. Similarly to the concept of POUS, quality of the source can be used at virtually every step in a process.

It is particularly important to use quality at the source when dealing with information management. Poor quality of information is a significant source of waste in many organizations today. Inaccurate information passed across an organization introduces virtually all nine wastes to varying degrees. Here are a few simple examples. Has order processing entered all of the specific information required to process an order effectively for your customer? Can your order be processed defect-free and delivered in 100% compliance with your customer specifications? If not, you could benefit from quality at the source in this process.

When considering a new process, process revision, or revised facility layout, quality at the source should be an integral part of that process. As with other Lean concepts, there is a Lean tool, mistake proofing, that supports this effort and is often used to achieve quality at the source.

Just-in-Time

Just-in-time (JIT) is a concept that is used to describe the just-in-time delivery of all services or materials to the next process in your VA process. The objective of JIT is to make sure that we minimize the amount of materials that we have in our possession at any point in time. Many organizations have business measures based upon inventory dollars or inventory turns. The concept of JIT was instituted to minimize the waste of excess inventory and the negative cash flows of inventory carrying costs.

In a JIT environment, the universe of inventory is examined in detail with the ultimate target on minimizing inventory costs. Non-Lean organizations carry significant amounts of raw materials inventory, often measured in days', weeks', or even months' supplies. Typical world-class organizations carry much less inventory, with some inventory supplies being delivered to their operations in 2- to 4-hour increments.

How much inventory we have, how we purchased this inventory, how we receive and store this inventory, how we move our inventory around a facility—these all impact whether or not we are using JIT philosophy.

All inventory represents cost for your organization. The greater your inventory levels, the greater your inventory carrying cost will be, and as a consequence, this cost will have to be reflected either in your product price or in decreased profitability.

Kaizen

The term *Kaizen* has been described several ways. *Kai* means *change*, while *zen* means *for the better.* Another translation would be *change* plus *improve*. Kaizen is most commonly described as continuous improvement. Kaizen is the foundation of all Lean or LSS process improvement initiatives. Kaizen can be conducted individually, as a part of a process improvement team, or as a response to process troubleshooting. These three fundamental applications of Kaizen are present and readily observable in all LSS organizations. A detailed description of the application of Kaizen concepts is presented and discussed in Chapter 5.

Regardless of whether you conduct Kaizen individually, as a team, or in process troubleshooting, applying Kaizen for process improvement requires several activities. First, one must be able to look at and take apart the current process. Second, you must be able to analyze all the elements of that process. Finally, based upon this analysis, you must be able to define an improved set of steps in the process that you were investigating.

While much of the literature today refers to Kaizen as a tool (and many organizations use Kaizen events as a sole tool for improvement activities), Kaizen is the single most important LSS operational philosophy. It is clearly the most underlying fundamental concept required for successful and sustainable process improvement. The ability to deploy Kaizen in any of its forms is a primary requisite to becoming an LSS manager. To this end, Lean practitioners actively engage all employees at all levels of the organization to practice Kaizen on a daily basis.

5Ms: Materials, Machines, Manpower, Methods, and Measurements

The 5Ms—materials, machines, manpower, methods, and measurements—represent categories of process input variables. In every organization each category is composed of several key process input variables (KPIVs). The sum of all the KPIVs contained in each of these categories can be used to provide an accurate description of your value stream.

Understanding the nature of each of these categories allows the Lean practitioner to accurately describe the component of your organizational processes and how each component influences the quality of product or service delivery for your customer.

Key Process Input Variables

Fundamental KPIVs are in essence composed of all the resources required to add value for your customers. More effective use of resources is typically a target of organizational process improvement programs. For example, under the category of materials, one can identify a series of questions that may require analysis in any process improvement project. Some of these questions may include the following:

- Which raw materials are needed?
- How much of each of these raw materials is needed?
- When were these materials purchased?
- How much of each material is purchased?
- How would these materials be packaged by my supplier?
- How often do I take delivery of each material?
- How are the materials transported to my facility?
- Where will the materials be stored within my facility?
- When and how will the materials be transported to the VA location?
- How are they consumed in our value-adding processes?

Key Process Output Variables

Key process output variable (KPOV) is basically another term used to describe output measures that you want from your processes. Usually KPOVs are measures or specifications that your customer has placed upon you for service or product delivery. For example, one customer may want a certain or specific on-time delivery of your product or service, say, within two business days of order. Another KPOV could be defined as some aspect of product specification.

KPOV can be either internally focused (designed to achieve an internal organizational measure) or externally focused (designed to meet some functional requirements set for you by the customer). LSS organizations attempt to focus KPOVs on attributes that are defined by the customer. Although a few internally focused measures may be desirable, great care

must be taken not to have too many of these in your internal processes. Internally focused measures tend to drive organizations to take their eye off customer requirements. This is a common mistake of traditional organizations that typically develop a large number of KPOVs that are internally focused, and as a consequence, leads them to situations where they produce poor-quality product for their customers.

LEAN TOOLS

In this section, we describe the most common Lean tools used in industry today and the fundamental nature of each tool. We discuss the purpose of the tool, when it is used, and some of the important aspects of why this tool is an essential component of your Lean transformation process. These sections are not meant to be comprehensive in nature. There are many Lean tool books that provide both in-depth descriptions and the methods of applying these tools.

As stated earlier, Lean is an operational philosophy, and in reality, there are a relatively small number of Lean tools. The real power in applying Lean tools is in coupling this effort with one of the previously described Lean concepts. One of the largest misconceptions in American management today is that Lean tools in and of themselves will produce significant productivity improvements. Applying Lean tools solely as tools does not yield the process improvement that many organizations are attempting to achieve or that are typically associated with true Lean initiatives. An overview of the prominent Lean tools is presented in the remainder of this section.

5S Workplace Organization and Standardization

Definition

5S Workplace Organization and Standardization is an LSS tool used to organize basic housekeeping activities and standardize materials, machinery, manpower, and methodologies used in your value-adding activities.

Just the Facts

The most fundamental of all the Lean tools is 5S Workplace Organization and Standardization. The concept of 5S Workplace Organization and Standardization was presented in the book entitled *Five Pillars of the Visual Workplace*, by Hiroyuki Hirano.[1] Workplace organization and standardization is a fundamental building block of any LSS organization. As described in the Lean concepts section, the Holy Grail in any process is continuous flow. If a process is poorly organized or not standardized, it is very difficult to establish continuous flow. This is one reason most organizations begin an implementation of Lean with the fundamental introduction to 5S Workplace Organization and Standardization. There are many case studies in the literature that cite the importance of 5S to their Lean initiatives. Moreover, an effective 5S program is a prerequisite to applying Lean tools, and achieving sustainable meaningful results.

The purpose of 5S is to arrive at a safe, neat, orderly workplace where everything required to perform for your customer is readily accessible by your employees. Implementing 5S Workplace Organization and Standardization results in a commonsense work area with an organized sequence of activities required in your VA processes.

5S Means Action

5S Workplace Organization and Standardization programs are composed of five phases of activities. Each of these five phases is required if your organization is to successfully implement a 5S program.

Sort: The first S is sort. Sort means you select a target area and sort through everything that is in that area. The objective is to eliminate anything that is not needed. That means you are trying to leave only the bare essentials that are required for the VA steps in that area.

At first glance, this may seem like a very easy thing to do. However, once you begin this process of sorting, you will quickly find that there are a large number of things in any given area that are wanted but probably not needed. Because this is common in most organizations, a procedure has been established to help with the sorting process. This procedure is referred to as red tagging.

Note: It is very important that the red tag is used to indicate that the item is *wanted but not needed* and is readily differentiated (size, shape, and shade of red) from the red tag used on rejected parts.

Red tagging is a concept whereby employees sort through *everything* that is located in the target area. When conducting red tagging, a few simple questions are used to decide whether or not what you have identified is needed or not. Is this item needed? If so, where should it be located? Also, what quantity of this item is needed? During this process you will run across a large number of items that you are not sure what to do with. These items should be *red tagged*. A red tag is nothing more than a tag that identifies critical information about the item, such as what the item is, where it was found, what date you found it, reason it was tagged, and possible disposition for the item. Once red tagged, the item is moved to the red tag area, where it is reviewed by a supervisor or manager for proper disposition.

Set-in-order: Once the sorting is completed, you are ready for set-in-order. The process of setting items in order of use is very simple in concept; however, it requires discipline on the part of the user to identify exactly where all VA materials should be stored and how they should be prepared for use in everyday activities. The act of setting items in order by its very nature requires that the Lean practitioner standardize the work area. Care should be taken during this process to consider all employee interactions. For example, one should consider the workforce, such as, are the employees right-handed or left-handed? Are there possible disabled or handicapped employees, and how do we set-in-order for the employee that may be color blind? These are critical factors for set-in-order.

Once completed, it should be visibly obvious to all where every tool, material, fixture, or other items used in the VA process are to be stored. This process of standardizing the workplace makes it easier for multiple employees to use the same work area and complete VA activities in a standardized fashion.

Shine: With sort and set-in-order completed, the next objective is to make sure that the entire area is completely clean. Shine is another simple activity; it just requires that you clean an area and make it ready for use. Typically, there are two valuable components of the shine activity. First, make sure that the entire area is clean and swept; this includes floors, aisles, and any areas in or around where VA activities need to be conducted. Second, owner's shine has to do with the removal of dust or dirt or grime from any of the floors, workbenches, tables, computer areas, and office equipment that are in use on a daily basis. Adding the discipline of shine to your 5S program requires that you really take a close look at

everything that is used in the VA process. The result of this is that once completed, everything in or around the work area is in a state of readiness for use whenever it is needed.

The importance of shine cannot be overstated. Organizations that fail to do a thorough shine process inevitably regress to a less organized, less productive work space. The planning process should become a fundamental component of our everyday activities. To make the shine activity a standard part of your operational procedures, one may choose to look at it similarly to that of personal hygiene. Few, if any of us, would consider leaving for work in the morning without performing any one of a number of various activities required to make ourselves personally ready for our day, that is, taking a shower, brushing our teeth, and fixing our hair. This kind of philosophy needs to be adopted during the shine campaign in your organization. It must be daily. It must be routine. It must be a part of who the organization is.

Another reason that the shine campaign is so important is that defects are often hidden in a clumsy, dirty, dusty, dark, or otherwise unclean environment. Many of the defects that we produce are often tied to an unclean work area. The cleaning process also affords the employee time to take a closer look at all of those items—materials, tools, computers, and so forth—that we use during the VA process. This type of inspection allows us to identify potential problems before they become too serious and result in poor-quality products or services for our customers.

Standardize: The concept of standardize is a little different from the concepts of sort, set-in-order, and shine. Standardize requires a different thought process and is a technique that is used to define the consistent application of sort, set-in-order, and shine activities. Standardize is the difference between a sporadic, once-in-a-while approach to workplace organization and a systematic, continuous, and routine approach to maintaining your work space. Organizations that do not put the fourth S—standardize—in place and do not make standardize a daily habit revert back to old habits, and as a consequence, the workplace is never maintained in a state of readiness.

Standardize is the phase where companies begin to falter. The reason for this is that we have many activities that happen on a daily basis that we would consider not standard in our workplace. That means there are many things that happened only once in a while or only today or only this week. The result is that materials that are often used or excess supplies required

for a one-time event begin to creep into our work spaces. When we apply standardize on a daily basis, it forces us to take action on these one-time events, that is, to change the uncontrolled *happen* event into the controlled or standardized *occur* event. How often have you heard yourself say "I'll just put this here" or "This is just for today" or "We never really do this, but I have to do it this way this afternoon." Each of these thought processes results in the breakdown of standardize and the circumvention of sort, set-in-order, and shine philosophies.

Ultimately, the essence of standardize is to prevent any work area from returning to its original disorganized state. This is typically accomplished by using standardized tools, such as checklists or check sheets, cleaning schedules, and a visual map of what the area should look like. These tools typically identify all the activities required to effectively complete sort, set-in-order, shine, and standardize on a daily basis.

Sustain: The fifth S is sustain. If your organization is to be successful at maintaining an effective 5S program, you must develop the discipline to keep sustain alive in your organization on a daily basis. This means allowing the time, energy, effort, and resources required to maintain your 5S program. Sustain is nothing more than making a habit of sort, set-in-order, shine, and standardize activities. It is basically demonstrating that your organization is committed to a company culture that accepts nothing less than a daily active 5S Workplace Organization and Standardization program. Many organizations make it through the first four S's, yet lack the commitment to make it a part of their core daily activities. As soon as the sustain efforts dwindle or falter, your organization will revert back to its previous disorganized environment.

Common Omissions When Implementing 5S

The 5S Workplace Organization and Standardization tool is for everyone everywhere in the organization all the time. It is both a concept and a tool encompassing an everyday way of life in your organization. The strength of the tool is that it can be started small; by that we mean that it can be used to improve small areas of your organization independently. Ultimately, the entire organization should be implementing 5S to the point where it is part of the organizational DNA. Unfortunately, efforts commonly falter at the standardize and sustain phases. In many organizations a casual walk-through exposes the remnants of past failed attempts

to embrace and adopt this, the simplest of Lean tools. Ten common omissions from 5S programs are listed as follows; these are implementation aspects to keep in mind when adopting a 5S Workplace Organization and Standardization program:

1. Not including the entire facility, inside and out. This includes every space—office, parking lot, hall, work space, closet, storage area, warehouse, break room, bathroom, copy center, call center, distribution facility, company vehicles, and so forth.
2. Not including the entire staff. If anywhere in your organization the mind set of *5S is for someone else* is present, your 5S program will not be successful.
3. Abandoning the 5S effort before all required 5S activities are in your organizational DNA and are a visible, daily, and cyclic set of commonly reoccurring activities.
4. Not allowing employee time for complete 5S understanding and implementation.
5. Not allowing employee time for regularly scheduled 5S activities to be conducted at certain points in the day or night, daily, weekly, and/or monthly.
6. Not investing in required housekeeping and standardization tools—cleaning materials, visual control indicators, or standard location markers.
7. Not documenting 5S activities. Many companies go through an initial 5S program, and because the concepts and activities are simple in nature, they do not document and standardize the processes. Checklists, cleaning schedules, visual maps, before and after photos, and visual controls are all essential components of 5S documentation.
8. Not having 5S standard work for all associates, managers, and executives. That is right—managers and executives. It is commonly recognized that today manager standard work is essential for 5S success.
9. Not setting up a 5S visual workplace display that shows the entire company's participation in the 5S program and is a living evolving display of ongoing 5S activities company-wide.
10. Not encouraging, supporting, acknowledging, and rewarding employee participation for ongoing creative 5S activities.

Overall Equipment Effectiveness

Definition

Overall equipment effectiveness (OEE) is an LSS tool used to monitor equipment effectiveness by measuring equipment availability, performance, and product quality of the equipment. In semiautomated or fully automated environments, OEE becomes a foundation for total productive maintenance (TPM) programs and LSS process improvement projects.

Just the Facts

OEE is a tool that was developed predominantly for the manufacturing sector. It was created to measure equipment effectiveness in companies that use equipment to add value or create products for customers. This tool is perfectly suited for this outcome. However, the strength of this tool conceptually reaches far beyond equipment and can be applied in many nonmanufacturing environments. In addition to its application in a manufacturing environment, we will also show how to modify the OEE calculation to be used in nonmanufacturing environments.

The primary purpose of OEE is to measure how effective your VA equipment usage is. In a manufacturing environment, OEE is also a secondary measure of productivity. OEE is often used as a foundation for evaluating the TPM programs and deciding where to apply your maintenance dollars to receive the greatest improvement impact on equipment reliability. A well-run OEE measurement system can also be used as a foundation for assessing new capital equipment acquisitions.

Although OEE is an effective tool, as with all measures, there is one caveat here. The concept of optimizing equipment utilization at the expense of other key process inputs, such as materials or manpower, was a common mistake when OEE was first introduced, and is still present today. In an environment where salaries were low and equipment costs were high, it was easy to fall into the trap of requiring employees to be chained to equipment to achieve high productivity levels. An LSS environment mandates that we balance the proper amounts of materials (to reduce inventory), equipment (to meet customer demand), and utilization of the human factor (to be flexible to changing customer requirements). This synergy of process inputs demonstrates effective use of Lean concepts and

tools and reinforces that we maintain a true process focus. It also provides a foundation that steers us away from the common misuses of LSS tools.

How to Use OEE

The use of OEE relies on three direct measurements of your equipment and the products produced by your equipment. These are equipment availability, equipment performance, and product quality. In essence, the objective of OEE is to identify and quantify equipment-related losses that decrease productivity. Once identified, these loss areas are targets for Kaizen.

Equipment availability: Equipment availability is a measure of equipment readiness when your organization needs equipment to add value. This is basically composed of scheduled operating time minus any downtime losses that occur during that scheduled operating time. The result of the equipment availability analysis is the actual time that your equipment was running. This is often referred to as runtime or uptime.

$$\text{Availability} = \text{Uptime} \,/\, \text{Scheduled operating time}$$

Equipment performance: Once the runtime has been established, we can look at equipment performance. Equipment performance is defined as your target output for equipment running at maximum speed minus any speed losses that occur during operation. The result of equipment performance analysis is your actual output.

$$\text{Performance} = \text{Actual output} \,/\, \text{Target output}$$

Product quality: Product quality is a measure of your good product divided by actual (total) output. The result is your good product output.

$$\text{Quality} = \text{Good products} \,/\, \text{Actual output}$$
$$\text{OEE (\%)} = \text{Availability} \times \text{Performance} \times \text{Quality}$$

Applying OEE in Nonmanufacturing Environments

The concept of OEE can also be used in nonmanufacturing environments. To use the OEE calculation in nonmanufacturing environments all one needs to do is replace the middle term *equipment* with the term VA. This

gives us overall value-added effectiveness (OVAE). We can now define OEE in terms of OVAE.

Value-adding availability: Every organization today conducts some form of VA activities for their customers. To complete the OVAE, your organization must define an element that adds value for your customers. This could be in the form of the number of process inputs that add value. For example, this could be the number of employees available in a service industry environment. In the health-care industry, this could be the number of nursing staff available in a specific wing of the hospital. In a call center, this could be the number of call center representatives available to take incoming calls. The VA availability component of OVAE is therefore:

VA availability = Working time / Scheduled time

Value-adding performance: Value-adding performance can be defined as your actual service delivery output divided by your target service delivery output. Similar to working in an equipment environment, VA employees run into a number of speed-related delivery losses during their daily activities. The VA performance component of OVAE is therefore:

VA performance = Actual service delivery output /
Target service delivery output

Product or service quality: Whether you are delivering a product or a service to your customer, the quality of that product or service can be measured. Service delivery defects can be described as actual service output divided by good service output. The service quality component of OVAE is therefore:

Service quality = Good service output / Actual service output
OVAE (%) = VA availability × VA performance × Service quality

Mistake Proofing

Definition

Mistake proofing is an LSS tool used to minimize or eliminate mistakes (errors) that produce defects in a product, a process, or a service.

Just the Facts

Mistake proofing[2] is a tool that is used to minimize or eliminate errors and their subsequent defects in any process. No matter how hard we try, whenever we put together materials, machinery, manpower, and methods, we are bound to make some errors. These errors produce unwanted defects for our customers. The art of mistake proofing endeavors to eliminate mistakes where they occur by redefining activities and developing techniques to mitigate the defect before it happens.

So what is the purpose of conducting mistake proofing in our organization? Why would you want to eliminate mistakes from occurring in our organization? First, eliminating mistakes basically means that we are improving performance for customers, helping to generate customer satisfaction, and ultimately customer loyalty to purchase our product or service in the future. One way to look at mistake proofing is as a program to guarantee future income for your organization.

Another critical reason to conduct mistake proofing is that mistakes introduce additional cost to your product or service. Every time a mistake occurs, additional actions need to be taken before you can deliver your product or service to your customer, all of which add cost and no value from the customer standpoint. Many of these mistakes detract from company profitability but are not accounted for in everyday productivity monitoring systems.

Another factor is that every time a mistake occurs, resources are used. That means that lowering the number of mistakes in your organization will inherently be lowering how many resources are required by your organization at any point in time. This further decreases the overall cost of your product or service.

How to Use Mistake Proofing

Mistake proofing is typically applied using some variation of the plan–do–check–act (PDCA) cycle. It is primarily a tool to help your organization achieve the Lean concept of quality at the source. In its most basic form, your objective is to isolate any process step or task during the do–check portion of the PDCA cycle. Achieving an effective check at the point of execution is critical to assuring that no error, mistake, or defect is produced at any individual process step and passed along to the next VA step.

One way to achieve this is by applying the concept of *negative analysis*.[3] This technique is used to identify and define what can go wrong in a

process, and subsequently designing a process that will not allow a mistake to occur. The analysis includes observations and investigations of the interactions between materials, manpower, and equipment during the process. Creative, *no-mistake* solutions are developed as a result of the negative analysis.

Mistake proofing can be used wherever there is an interaction between two entities during a process step. Some examples include interaction between two employees, an employee–customer or employee–supplier interaction, an employee and a piece of equipment, an employee–material activity, an employee–method step, or during any measurement activity. For example, an office environment example of mistake proofing may be something as simple as setting the fields of an order entry form so that an inaccurate piece of data could not be entered.

With the ever-increasing accuracy and speed of digital photography, even high-speed manufacturing processes (e.g., stamping) are able to inspect and record, via digital photograph, products that are produced at thousands of pieces per minute. As soon as a manufactured piece is out of a predefined visual specification range, the machine is stopped. Prior to this type of technology, thousands of pieces would have been stamped, creating a tremendous number of defects at a substantial cost to the manufacturer. This type of mistake proofing technology virtually eliminates the need in many instances for tedious and expensive quality control checks.

Cellular Manufacturing

Definition

Cellular manufacturing is an LSS tool used to organize VA activities into the most effective (highest productivity) and least resource consuming (lowest cost per unit) series of activities to deliver the perfect product or service to the customer.

Just the Facts

Cellular manufacturing is best described as a Lean tool that is used to make the best use of resources during your VA activities. These resources typically include raw materials, manpower, equipment, and facilities. Manufacturing cells are most effective when there is a known steady

demand for your product or service and products can be grouped by common VA steps. With customer demand known, you are able to sequence the flow of materials in your facility and apply the necessary manpower and equipment to best deliver your product. Creating a cell typically requires that we tie together all manual and semiautomatic (equipment) VA steps with the ultimate goal of making all of the VA steps and consequently your product flow at the demand of the customer.

As with all manufacturing process improvement tools, the primary purpose of cellular manufacturing is to enhance customer satisfaction and improve organizational profitability. A well-designed manufacturing cell can provide several positive outputs for both the company and the customer:

- Decrease lead time to your customer
- Improve product quality
- Decrease total inventory required and inventory carrying costs
- Minimize labor content as a percent of product cost

Since the inception of cellular manufacturing and one-piece flow concepts, it has been generally accepted that manufacturing cells produce the highest-quality products, allow for the highest productivity, and ultimately produce the highest profitability when compared with traditional in-line manufacturing processes.

How to Create Manufacturing Cells

The application of manufacturing cells draws together the use of several Lean concepts previously discussed. These include POUS, quality at the source, JIT, Kanban, and facility layout (i.e., process flow layout, not a function department layout), to name a few. The objective in cell design is to identify and eliminate as much NVA time and activities as possible from the current process by organizing all VA activities in the best sequence.

There are five key steps to the successful design and implementation of a cell:

Step 1: Group products. The first step in cell design is to understand your product groupings. To do this, you must first construct a list of products and then identify all the process steps required by each product. It is usually easiest if you just make a matrix with product

types on one axis and process steps on the other. After checking off which process steps are required by each product, it is easy to identify and group products by their respective process steps. After your products have been grouped, you can undergo the task of creating specific cells to manufacture or assemble all the products in each group.

Step 2: Measure demand (calculate takt time). Once the products have been grouped, we must now calculate or measure the demand rate of each product. The demand rate is just the rate at which your customer requires that you produce your product or provide your service. The demand rate is the amount of working time available divided by the number of units sold and is typically reported as units per hour or activities per day. Understanding the demand rate of your customer is a critical prerequisite to designing a cell. Cells typically work best when the demand rate is somewhat constant. If your demand rate is erratic or unpredictable, you will need to consider adding a visual control supermarket along with your cell design.

Step 3: Chart current work sequence. For each product you must next chart your current work sequence. This is typically accomplished using a time observation chart to document each element of the work sequence and record the time to complete each work sequence element. This time observation process is an essential complement of deconstructing work activities and then reassembling them back into a new and balanced continuous flow work sequence.

Step 4: Combine work and balance process. Once you have accurately recorded times for each element in the work sequence, you are now in a position to combine some work elements and balance the process to achieve the correct demand rate or output for the customer. This is accomplished by grouping elements to achieve the time that is less than or equal to the demand rate. For example, if the calculated demand rate is 10 minutes per unit for a specific product, then each individual element in the work sequence must be 10 minutes or less to complete. The closer you get each individual element to 10 minutes, the more continuous and smooth your work product flow will be. Work sequence balancing is not an exact science, but with some analysis of your time observation chart you will clearly be able to recognize significant disruptions in work flow associated with unbalanced work element times.

Step 5: Create new cell work sequence. After completion of steps 1–4, you are now in a position to create a completely new work cell sequence. During this step you complete a work flow layout that includes all materials and equipment manpower required to complete the work sequence. The primary objectives are to (1) simplify material flow by integrating process elements, (2) minimize material handling, and (3) make use of people for 100% of the demand rate time. In essence, your goal is to tie together and establish continuous flow of each work element. How you sequence these is dependent upon the actual work elements; however, it is best achieved by using one of the known successful cell configurations. The most common include the U-cell and S-cell configurations.

Kanban

Definition

Kanban means *signal*. It is an LSS tool used to make visible the requirement for action on the part of employees.

Just the Facts

Kanban[4] is the Japanese word for *card* or *sign*, whose function is to relay information along with materials that tell employees exactly what to produce at any given point in your process. Most VA processes have a significant number of process steps. The beauty of Kanban is that it connects a series of process steps in a fashion that allows continuous flow. As we discussed earlier in this chapter, continuous flow is the Holy Grail of any process. Kanban is a critical tool to establishing flow in a process.

The purpose of using Kanban in a process is to regulate the flow of information and materials between employees by connecting sequential VA process steps. Kanban systems allow you to define the exact quantities of products that are required to meet your customer demand. The benefit of this system is that you produce only what the customer requested, therefore eliminating any tendency for overproduction, one of the nine wastes.

How to Use Kanban

Kanban is used as an information-inventory control system by two sequential steps in the process. It can be used by steps that are directly adjacent to each other, those that are separated by great distances, or between different types of equipment at varying stages of your VA process. The Kanban signal system answers the question of *what to do next* that is required by employees to achieve high levels of productivity. One caveat is that Kanban typically only works well within stable demand environments. With the relatively stable demand, order points and order quantities within successive steps of the process can be defined. These are the foundation of a Kanban system.

Typically, a Kanban card identifying product name, photo, requesting department, and quantity desired is shuttled between the consumer of the product and the producer of the product.

Kanban is also a very powerful supply chain tool. It can and is being effectively used to make the supplier–customer materials management process more effective up and down the supply chain. Kanban containers are common tools between world-class organizations managing materials to meet customer demand.

Another method of Kanban signals is with vendor-managed inventory scheduling. This typically has a supplier being granted secured access to the customers' information management system to monitor the real-time direct consumption of products. At prespecified points of consumption, the supplier is signaled to prepare and ship product. This practice is becoming more common as companies strive to decrease lead times and inventories by taking advantage of global information sharing technologies. World-class companies are partnering through technology to create value for each other in ways not possible just 10 years ago.

Value Stream Mapping

Definition

VSM is an LSS tool used to map all activities (both VA and NVA) across your value stream. The tool allows for a visual representation or maps of resources allocation as you conduct business today (current state) as well as how you plan to add value in the future (future state).

Just the Facts

VSM is a technique that is used to develop a visual representation of all the activities required for you to add value for your customer. It is typically conducted in a two-step process. The first step is to construct a current state map. In the current state, you review every single activity that is currently being conducted to provide your product or service for your customers. The current state map is used to give a fairly accurate definition and description of what your organization currently does for your customer. This is critical for your organization to begin to understand the weaknesses of your current process and to identify what needs to be improved to improve performance for your customer. During the creation of the current state map, identify on the map as many of the nine wastes as possible, indicating where these wastes are present. Once a current state process map has been completed and significant waste throughout the process is identified, the second step of the VSM program can be completed, which is preparing a future state map.

The future state map defines and outlines a visual representation of how you want your organization to perform at some point in the future. It typically endeavors to describe an ideal state, that is, a state in which you identified and eliminated a significant amount of waste that existed in your current state map.

There are many software packages available today for VSM. Some are simple icon-based systems to help with preparation of current state and future state visual maps. Others are more complex and allow for the inclusion of many process variables, such as materials, employees, and cycle times and/or lead times. The most complex allow for computer process model development and sophisticated simulations of *what if* process change scenarios of selected process variables. Regardless of the complexity of your selected VSM solution, all options can allow you to significantly improve your processes using the VSM techniques.

Managing with Maps

Using VSMs to manage improvement activities is an effective way to organize, prioritize, deploy, and manage improvement activities. Using a technique called managing with maps is an effective approach to tie process performance acceleration and align organizational objectives from strategic plans to tactical improvement plans. In *The Organizational Alignment Handbook*, we describe the seven phases of the organizational

alignment cycle.[5] The managing with maps technique would be developed and deployed in phases I, II, and VI. A brief overview of using managing with maps to align and manage organizational objectives is given below. Each view would require the preparation of current state and future state views at each level in the organization. These maps are used as the primary improvement management tools.

Strategic view: The strategic view VSM shows a complete view of the value stream from customer contact to customer receipt of product or service. It identifies high-level process steps and includes key departments, high-level performance measures that all lower-level measures will roll up to. This map should allow all employees to see how their participation supports the organization's strategic objectives. It also identifies high-level improvement initiatives targeted for the map time period.

Department view: The department view VSM shows a complete view of the value stream within a department. It identifies department-level process steps and assigns key department measures. These maps encompass resources coming into or being used within the department and all the VA products or services exiting the department. It identifies Kaizen activities or continuous improvement team activities.

Process view: The process view VSM shows a complete view of each process within a department. It identifies detailed views of each process and assigns key department measures to each process. These maps encompass resources coming into or being used within each process and all the VA products or services exiting the process. It identifies Kaizen activities or continuous improvement team activities, current state performance, and future state targets for improvement.

Measure view: The measure view VSM shows a complete view of all measures within a process. It identifies specific measures of various process steps and allows for monitoring and aligning multiple measures of a process. Using this technique allows for measurement management and eliminates conflicting measures within a process. This is particularly important in complex systems or regulated environments such as health-care or medical products manufacturing.

Using the management with maps approach allows complete organizational alignment. It provides a mechanism for measurement roll-up from

the most specific process step measurement to department objectives, and ultimately to strategic initiatives. These VSMs are a powerful visual management and communication tool.

Visual Controls

Definition

Visual control is an LSS tool used to describe *what to do next* for employees without using words. They are pictures or diagrams used to regulate employee activities, such as displaying activity instructions, identifying safety hazards, or restricting employee access, to name a few.

Just the Facts

Visual controls are simple signals that show at a glance what needs to be done. They are simplifications of systems that, when implemented effectively, require no communication between employees to signal what action should be taken. Think about that for a second—no communication! No e-mail, no information management system interaction, no phone interaction, no reading standard operating procedures, or good manufacturing practices. These are all no-value-adding, time-robbing activities that the customer is unwilling to pay for.

Some visual control examples that describe necessary actions are where a material should be moved, what raw material or subassembly should be replenished, which orders need to be entered, which patients should be waited on first, and so forth.

How to Use Visual Controls

Visual controls are becoming more and more prevalent in many organizations. In multilingual environments, visual controls can eliminate the need for translations. In organizations where employees may have handicaps, such as color blindness, for example, visual controls using geometric shapes can be incorporated into work instructions.

The visual control example in Table 9.3 will assist you in developing visual controls in virtually any environment. The table puts together control type, purpose, and several examples of common controls. This is a

TABLE 9.3

Visual Control Examples

Type	Purpose	Description
Items or parts	Identify the correct item or part	Signboards, photos, labels
Locations	Identify the correct location	Color coding, numbering, tape outlines
Quantities	Show the proper quantity	Min-max levels, container quantities
Methods	Describe the method	Standard procedures, visual work instructions, charts
Exception tags	Indicate special conditions or abnormalities	Read tags, repair tags, quarantine signs
Andon signals	Signal employee action	Visual flashing or rotating lights, bells, or buzzers
Kanban	Control materials movements	Card, containers, or empty spaces signaling production is required
Performance measurement displays	Visually show performance versus target	Safety, quality, or productivity performance measures
Defect displays	Make visible common problems	Board or table showing defective raw materials, tooling, or paperwork
Personnel boards	Show current availability or assignments	Availability (in/out), assignment department, or location

powerful tool for process improvement. Now that you have been introduced to them, look for aspects of your processes that would benefit from visual controls.

THE POWER OF LEAN CONCEPTS AND LEAN TOOLS

Throughout this chapter, we have described a series of the most common but powerful Lean concepts and Lean tools used in process improvement activities. In this section, we present an example that demonstrates the proper application of the Lean operational philosophy, which combines the Lean concepts and tools described in this chapter. The synergy, strength, and power of coupling a Lean operational philosophy and Lean tools to effectively organize key input variables (5Ms) are demonstrated in

this example. Remember, only by managing inputs can we improve outputs. When looking to harness the power of LSS, endeavor to use as many of the concepts and tools as possible along your process.

Several Lean concepts or tools described in this chapter were used in unison in the composite U-cell case study described in this section. The term *composite U-cell* simply means we joined two U-cells to establish continuous flow for the production of the entire finished product. This example also shows both creativity and innovation that can be achieved to arrive at simple solutions that deliver powerful process improvements. The following 13 Lean concepts and tools were used in the composite U-cell case study.

1. Continuous flow
2. Kaizen
3. Pull systems
4. Cell design
5. 5S Workplace Organization and Standardization
6. Standardized work
7. Visual materials controls
8. Visual work instructions
9. Kanban
10. Mistake proofing
11. POUS
12. Quality at the source
13. Facility layout

Composite U-Cell Case Study

Situation: A manufacturer of complex medical instrumentation was producing approximately 45 blood dialysis units/week operating two shifts in an enclosed electrostatic discharge room. The company was regularly receiving orders for 60 units/week. There was no room for expansion, and the company was restricted to assembly in the current assembly area. The challenge was to implement process improvements and achieve 60 units/week with the existing staff, assembly area, and test equipment. Previous attempts to increase production beyond the 45 units/week level had resulted in significant quality problems and an actual reduction in output.

Cell design activities: The Kaizen continuous improvement team created a *first of its kind* composite U-cell using the five-step cell design process.

The composite cell is actually two cells operating in unison. Cell design for each cell included product grouping, takt time, line balancing, work sequencing, and facility layout for a total of 38 workstations, over 50 assembly and test employees, and the assembly of over 4000 parts.

How the composite cell operates: Raw materials flow from the outside of each cell toward the inside of each cell via a series of subassembly workstations. Simultaneously, each major component, hydraulics assembly and chassis assembly, flows in the U-shaped pattern on the inside of each cell, consuming subassemblies along the way. Final assembly of the hydraulics and chassis takes place at the work center between the cells as the last assembly step before transferring the final product to testing.

Lean Six Sigma Concepts and Tools Used

Kaizen teams were used as the primary change management tool for cell design and implementation.

The Kaizen and you method was used by individual employees for bench improvements along with 5S Workplace Organization and Standardization.

During each cell design, the teams utilized continuous flow, pull systems, visual controls and instructions, standardized work, POUS, quality at the source, Kanban, mistake proofing, and facility layout.

During cell *try-storms* workbench layouts were designated, and POUS and materials flows were established with replenishment occurring as materials were consumed using visual controls and Kanban cards and containers quantities.

Quality at the source and mistake proofing were incorporated into employee subassemblies activities. Two space visual controls located on the subassembly work center regulated materials flow within the cells. As the hydraulics assembly consumes each series of subassemblies, workers at each subassembly bench were signaled to replenish these parts.

Well-defined takt time assured continuous flow throughout each cell.

Final assembly and testing proceeded without errors and subassembly rework that had previously hindered productivity.

Figure 9.1 shows details of the final composite U-cell layout, which includes raw materials' storage on the exterior of the cells, subassembly workstations, employee deployment, final assembly cart progression, and in-process and final test stations.

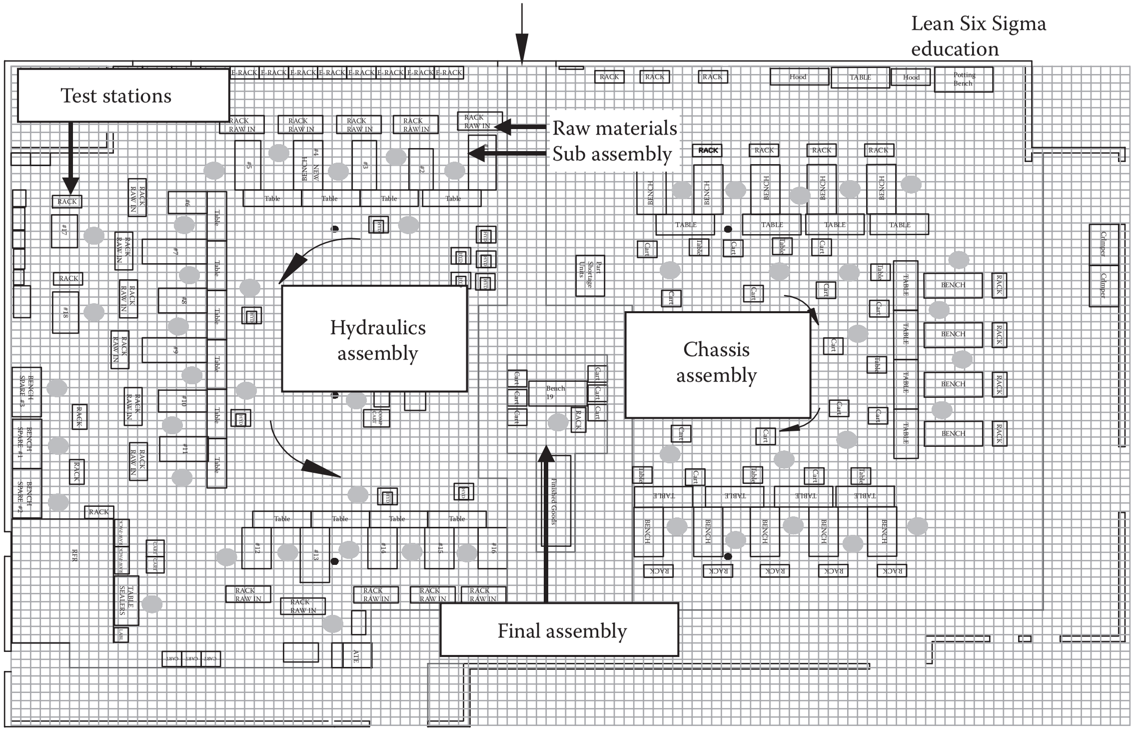

FIGURE 9.1
Composite U-cell layout. Economic impacts: Over a 60-day period the continuous improvement teams designed and implemented the integrated U-cells. The results were that the initial production rate of 45 units/week was successfully increased to 60 units/week with greatly improved product quality. This represents a 33% increase in the productivity using the same floor space, number of employees, and existing test equipment.

SUMMARY

There are four key LSS learning points to take away from this chapter. The true LSS manager or practitioner integrates these four characteristics into his/her daily beliefs and activities to achieve performance improvement.

Learn to *see* waste. Waste is almost everywhere in your organization. Increase your understanding of what causes each of the nine wastes. Wherever any of the 5Ms interact, there is waste potential. Notice the activities revolving around VA processes. Focus on materials, machinery, methods, man/woman power, and measurements. These inputs are source points for all waste creation.

Embrace the power of observation—stop and watch the process. Taiichi Ohno was famous for demanding observation of the process by his employees, so much so that he would draw a circle on the floor and make shop floor managers stand in it and observe the process until they identified and understood where the waste was. These events could last hours with Ohno's intermittent checks to see if managers could identify the waste. His learning objective was a simple one: You cannot improve a process when you cannot see what to improve or where to improve.

Learn the LSS concepts and apply the LSS tools. Begin to better understand the range of LSS concepts and how they interact with each other. Understand the warning signs that a traditional operational philosophy is at work and contributing to waste. These are typically starting points for process improvement projects. Apply the tools and monitor their effects on performance measures. Remember, LSS is a learning process. The more you use the tools, the better you will get at effectively improving processes.

Use the concepts and tools in groups to achieve enhanced performance improvement. Using LSS concepts and tools in groups can result in significant performance improvement. Revisit the composite U-cell case study as an example of grouping concepts and tools.

REFERENCES

1. Hiroyuki Hirano, *Five Pillars of the Visual Workplace*, Productivity, Inc., Portland, OR, 1995.
2. The Productivity Press Team is the Author. *Mistake-Proofing for Operators*, Shop Floor Series, Productivity Press, New York, 1996.

3. H. James Harrington, *Business Process Improvement: The Breakthrough Strategy for Total Quality, Productivity, and Competitiveness*, McGraw-Hill, New York, 1991.
4. The Productivity Press Development Team, *Kanban for the Shop Floor*, Shop Floor Series, Productivity Press, New York, 2002.
5. H. James Harrington and Frank Voehl, *The Organizational Alignment Handbook*, CRC Press, Boca Raton, FL, 2012.

10

Three Faces of Change: Kaizen, Kaikaku, and Kakushin

Kaizen—Small change
Kaikaku—Transformation of mind
Kakushin—Innovation

It is not necessary to change. Survival is not mandatory.

W. Edwards Deming

IN A NUTSHELL

Improvement means change. Today, more than ever the ability of an organization to change quickly and adapt to changing customer requirements is mandatory. Almost every employee in every organization is faced with the challenge of changing how they do things today into how they want to do things tomorrow. For managers, this can be a particularly daunting challenge. When discussing process improvement projects with managers, the Lean Six Sigma (LSS) practitioner will often be faced with a barrage of resistance-to-change challenges across the organization. We hear statements such as

- If only purchasing would do this or engineering would do that, our process could be improved.
- If this department would consider our needs, we would more effectively be able to deliver our product.
- If John's department could just deliver the materials that we need on time, our productivity would greatly improve.

These resistance-to-change scenarios are commonplace in many organizations today. This chapter is about gaining a better understanding of why there is so much resistance to change. How can successfully applying Kaizen to our change management activities be a fundamental approach to overcome this resistance? All LSS change management activities benefit from this approach, whether you are using a process change model of Define, Measure, Analyze, Improve, and Control or a design changes model using Define, Measure, Analyze, Design, and Verify (DMADV). We discuss how individual and organizational beliefs and behaviors are responsible for some of the resistance to change that we encounter.

If we are to become true LSS practitioners, we need to gain a basic understanding of the ninth waste, behavior waste, and how we apply Kaizen to eliminate this and other wastes and facilitate change in our organization. The ninth waste, behavior waste, teaches us that change and improvement begin with us as individuals (personal waste) and collectively (people waste) as members of an organization. In this chapter, we discuss the organizational path of change from a non-LSS environment to an LSS environment. The primary conduit of change management is Kaizen. Eliminating non-Lean beliefs and behaviors across the organization requires the sustained application of Kaizen.

Most organizations are familiar with Kaizen (small continuous) changes; however, Kaikaku (a transformation of mind), which demonstrates large change or radical change, and Kakushin (innovation) are equally important in your Lean transformation.

Kaizen[1] is not a new concept. It was coined in 1986 by Masaaki Imai in *Kaizen: The Key to Japan's Competitive Success*. This first book on Kaizen fully defines and describes the concept. One unique aspect of this book is that it gives us a look at how to apply Kaizen in a traditional organization. Coupled with his second book, *Gemba Kaizen*,[2] they represent powerful resources on change and process improvement available today. Concepts summarized and presented in this chapter are derived from these and other resources.

Kaizen is the lifeblood of a Lean organization and a Lean management system. It can be used individually, in teams, or for process troubleshooting. We show in this chapter that Kaizen is about taking positive action. Kaizen transitions into Kaikaku, a transformation of mind, and becomes the perfect conduit to deploy education, beliefs, and apply Lean tools across your organization.

The beauty and power of Kaizen, Kaikaku, and Kakushin is that they are easy concepts to learn, implement, and teach to others. Kaizen can become contagious (in a very positive sense) in your organization. You can always tell an organization that practices Kaizen within a few minutes of walking around the facility. The telltale signs are everywhere; there are visual controls and measurement systems. Kaikaku can be described as a series of Kaizen activities completed together, forming and exhibiting the presence of a Lean mindset. Kakushin or innovation is required for growth of all companies. Simply put, living the three faces of change—Kaizen, Kaikaku, and Kakushin—will show you how Lean can transform your organization.

INTRODUCTION

Kaizen means continuous improvement or change plus improve. Many of us as managers want improvement, but often fear change. We embrace change only if we can completely control it. In many instances, management today wants to know the exact outcome of change before it allows any employee to take even the most fundamental steps to improve a bad situation. We have exposed individual and organizational beliefs as the root cause of this type of employee behavior, and now will present the change management required to eliminate it.

We present Kaizen, Kaikaku, and Kakushin here as the three fundamental tools to deploy change in your organization. What is the nature of change? How do we let go of old beliefs and behaviors? What are we changing into? How does Kaizen, Kaikaku, or Kakushin solve or address all these change questions?

It is time for individuals, teams, management at all levels, and employees in all functional areas of the organization to embrace change and to become the change that we want to see in the organization. In the words of Mahatma Gandhi: "We must become the change we want to see."

This means that we cannot look outward for change. We cannot stand and say that it is the outside world that needs to change—some other employee, department, function, policy, or procedure that needs altering. Every individual in every organization can change aspects of many activities that touch their daily work environment. So, let us start on our journey of Kaizen. We will never be the same, and neither will the organization.

Resistance to Change

Organizational change is often more difficult than it first appears. Why is individual change so difficult? What is it that makes organizational change so difficult? These are fundamental questions that must be at the forefront of any LSS transformation process.

There are three fundamental aspects that prevent, hinder, or inhibit employees from participating in change management. First, there is fear of the unknown. Second is the measurement system. Finally, there are individual beliefs and collective organizational beliefs that present resistance barriers.

Fear of the Unknown

When we say *fear*, we do not necessarily mean fear of retribution from a manager or another employee in the organization. What employees typically fear is the unknown associated with any change to their environment. The change from where they are now and what they are familiar with to where the organization is going can cause trepidation on the part of many employees. Often changes are not clearly or completely defined. When there is uncertainty, people may be hesitant to walk into the unknown. Addressing this employee fear is a component of any successful LSS organization.

Measurement Systems

It has often been said that measures drive behavior and bad measures drive bad behavior, or non-Lean measures drive non-Lean behavior. In either event, the measurement system can be a significant source of resistance among employees, departments, or divisions of the organization. When embarking on any LSS project, understanding the nature of the measurement system that is in place is a critical factor to the success of the project. A review of measures may help in the formulation of your LSS project. Some types of measures that should be considered are as follows:

- Individual employee performance measures
- Department measures
- Division measures
- Bonus performance measures

- Process measures
- Productivity measures
- Customer-related performance measures
- Cost measures
- Corporate measures
- Stakeholder measures
- Regulatory agency measures
- Government regulation measures
- Risk management measures
- Liability measures
- Contract measures

Whether the ability to change these measures is real or just perceived, the above list can have a substantial influence on the resistance to change that you face on your LSS project. Clearly, many of those described can deter an employee on an LSS team from taking action.

Beliefs

Human beings have a fundamental desire to feel that the actions they are taking every day are correct. These actions are derived from each individual's beliefs. We normally do not look at ourselves as individuals who are deliberately doing something that is wrong. We generally believe that our behaviors and actions are "the right thing to do." Because of this, people tend to hold on to their beliefs and behaviors tightly, making it difficult to change a behavior pattern that is not producing effective performance of the organization.

OVERCOMING RESISTANCE TO CHANGE

Overcoming resistance to change is rarely easy and can range from a difficult task to a nearly impossible one. People tend to hold on to their beliefs fairly tightly. Many LSS efforts are stalled or fail outright because of the inability to overcome resistance to change.

There is a wide range of excellent literature on the subject of change management. Some focus on managerial psychology, whereas others use various tools and techniques, and still others present a combination of the

two approaches. In this section, we introduce the three basic phases that employees typically go through during the implementation of LSS concepts and tools for effective results.

Leaving Old Beliefs Behind

There are three distinct phases required to rewrite our beliefs in successfully transitioning to a new set of daily beliefs and behaviors. The first is to adopt the ability to *let go*[3] of our old beliefs to which we hold on to so tightly. The second is to open up our mind to the possibility of new ways of thinking and new ways of looking at the daily activities that we conduct. During this period of receptive activity to new ideas, it is incumbent that we try to implement these ideas in new ways in our organization. Over time, these new ideas become new patterns of behavior that become dominant; this third phase is identified as the emergence of an LSS environment.

So, how do we leave our old beliefs behind? What is the first step? One of the fundamental characteristics of operating in an LSS environment is the ability of its employees to challenge current beliefs and practices. These may be individual beliefs or organizational beliefs. Initially, this must start with the individual, who on a daily basis must become proficient at questioning whether or not the activities that he or she will be conducting today are creating value for the customer. When this practice becomes commonplace with individuals within our organization, we will be well on our way to developing the discipline to change old non-Lean beliefs.

Only when we have begun to adopt the concept of changing old beliefs can we even consider the possibilities of adopting a different way of doing things. Many companies today run into significant problems with adopting LSS concepts and tools simply because they are unwilling to change old beliefs. LSS is not a concept that can simply be slapped on top of an old belief system, deployed in a vacuum, and be successful. Trying to adopt LSS without letting go of old beliefs is a mistake made by many organizations today, and one of the leading reasons why many LSS initiatives do not produce the results anticipated and are unsustainable.

Considering New Possibilities

Considering new possibilities is a fundamental activity of Kaizen and the essence of this chapter. When we consider new possibilities, we open ourselves up to trying new things and begin to examine the way we think, our

point of view, and the methods we use in daily activities. Developing an organizational personality that considers new possibilities is the essence of LSS in that it allows a *learning environment* to emerge.

The identification and development of new possibilities is neither quick nor easy. It requires dedication at all levels of the organization and a commitment to practice Kaizen on a daily basis. Employees must be allowed the elbow room to experiment with try-storms to gauge the relative success of possible new improvements. They must be allowed the opportunity to make mistakes, course correct, and define better paths to higher productivity.

Management's insistence on a *results-only focus* can stifle the creativity of employees to try new process focus concepts. In this respect, Lean management becomes critical in the development of new processes. The rewriting of our beliefs requires an acknowledgment by management that our current belief system is ineffective and necessitates a deliberate management approach that supports the elimination of old beliefs followed by the consideration of new LSS beliefs.

Emergence of Lean Six Sigma

The continued practice of these two fundamental phases—leaving old beliefs behind and considering new possibilities—results in the emergence of an environment where individuals, groups, and your organization as a whole are on a journey to an LSS environment.

When considering change, start small and follow these simple steps. First, identify a waste in your organization and the old belief that contributed to the production of that waste. Second, put the old belief aside and consider new possibilities. Follow the three faces of change to become an LSS organization.

THREE FACES OF CHANGE

There are three faces of change that all improvement activities can be classified as: Kaizen, Kaikaku, and Kakushin. The fundamentals of each are presented in this section. True LSS organizations have employees well versed in all three, and activities of all three types of change management are visible across the organization.

Kaizen: Continuous Improvement

What is Kaizen? Kaizen has been defined in many ways. Several definitions follow to give you a range of interpretations of the term *Kaizen*.

1. Kaizen: Change + improve
2. Kai: To take apart and make new. Zen: To think or become enlightened
3. Kaizen: Continuous improvement using small incremental changes
4. Kaizen: When applied to the workplace means continuous improvement involving everyone, managers and workers alike

> It is not the strongest of the species that survive, nor the most intelligent, but the one most responsive to change.
>
> **Charles Darwin,** English naturalist (1809–1882)

In Lean organizations, management has two roles: maintenance and improvement.[4] *Maintenance* means to standardize and sustain a process, whereas *improvement* means to move the process forward to higher levels of performance. Virtually all process improvement programs start with standardize-do-check-act and move to plan-do-check-act (PDCA). Figure 10.1 shows this progression.

Kaizen process means to establish and live the PDCA cycle (see Figure 10.2).

- Plan: Establish a target for improvement.
- Do: Implement the plan.
- Check: Determine whether implementation has brought planned improvement.
- Act: Perform and standardize the new procedures to prevent recurrence of the original problem.

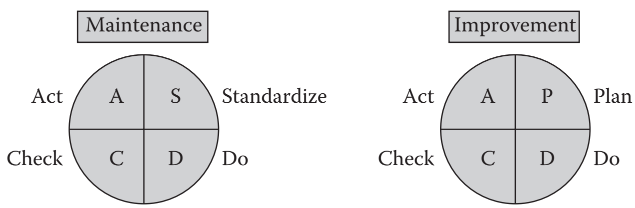

FIGURE 10.1
Standardize-do-check-act and plan-do-check-act cycles.

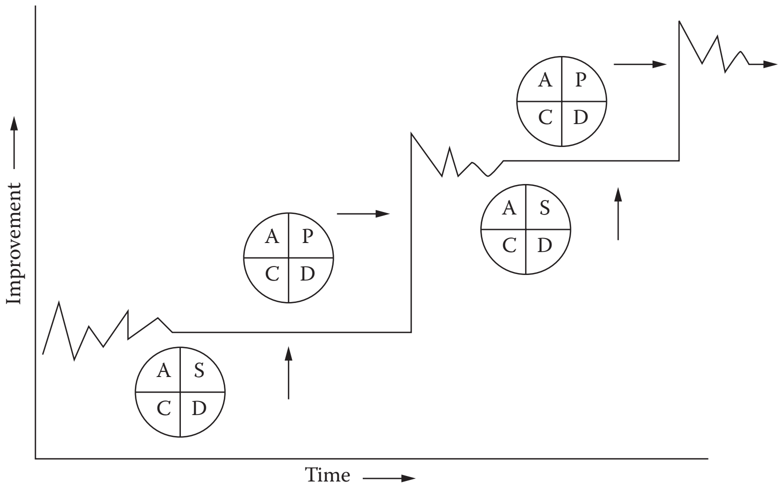

FIGURE 10.2
Implementing standardize-do-check-act and plan-do-check-act cycles.

Where to start Kaizen? If you are not sure where to start Kaizen in your organization, use the four K's of Kaizen; observe your organization, and start with one of the following:

- Kusai: Things that smell bad
- Kitsui: Things that are hard to do or are in dark areas
- Kitanai: Things that are dirty
- Kiken: Things that are dangerous

How do you use Kaizen? There are three basic approaches to using Kaizen effectively: Kaizen and You method, Kaizen for process troubleshooting, and Kaizen teams. Each is briefly described in this section.

Kaizen and You Method

Kaizen is change plus improve. That means making simple small incremental improvements that any employee can complete. With the Kaizen, and You method each employee can begin today to "change your point of view," "change the way you work," and "change the way you think." How can you start Kaizen today in your work area?

- Stop doing unnecessary things.
- Reduce: If you cannot stop, reduce them somehow.
- Change: Try another way.

There are three laws that make the simple concept of Kaizen work, but you absolutely have to do all three or you will *never* be good at Kaizen.

1. Surface: Write the idea down.
2. Implement: You make the change.
3. Share: Post it, review it, and talk about it.

With Kaizen you can change yourself and you can change your workplace. Kaizen should be done to benefit you. The person who gains the most from the Kaizen is the person who does the Kaizen. Start doing Kaizen today!

Kaizen for Process Troubleshooting

Everyone in your organization should completely understand and be able to successfully complete Kaizen using the following five-step process.[4] Employees who cannot complete this process cannot improve their individual areas, and consequently, you cannot improve the organization.

Step 1: When a problem (abnormality) arises, first, go to *Gemba*.
Step 2: Check the *Gembutsu* (relevant objects surrounding the problem).
Step 3: Take temporary countermeasures *on the spot*.
Step 4: Find the root cause(s).
Step 5: Standardize to prevent recurrence.

Step 1: Go to Gemba

Gemba is the most important place in your company. It is where *all* the value is created for your customers. This concept was so important that Soichiro Honda, founder of Honda Motor Company, did not have a president's office. He was always found somewhere in Gemba. Gemba means the *real place*, or where the *action* is. When a problem arises, go to Gemba first and look to solve specific problems.

Step 2: Conduct Gembutsu

Gembutsu means to assess all the relevant information in Gemba that surrounds the problem. Interview several employees; ask questions of what was happening when the problem occurred. Seek information in a

nonthreatening way; the employees in the area want the problem to be resolved as much as you do. Do not place blame, insinuate wrongdoing, or belittle an employee's work performance. This is a search for the facts of what happened. Remember to gather information regarding all 5Ms: materials, machinery, manpower, measurements, and methods.

Step 3: Take Temporary Countermeasures on the Spot

There is nothing more reassuring to an employee than knowing that management will support employees when problems arise. This is best demonstrated by a manager who takes sound action immediately. Your ability to remain calm in a critical situation and gather relevant information, understand the situation, and take action on the spot is one sign of good leadership and will be respected by all employees. Most importantly, it should be recognized by all, especially management, that these are temporary measures. The most common mistake is that organizations stop here at step 3; they never find the root causes, and consequently the organization lives with many *band aid* solutions that never get resolved and result in constant nagging poor-quality and poor-performance issues.

Step 4: Find Root Causes

Once temporary measures are in place, root cause analysis must be conducted. It is imperative that the root causes are found and eliminated. These can be conducted using techniques such as the 5 Why's cause-and-effect analysis, or failure mode and effects analysis. This is a critical step, for if the root cause(s) is not found, the organization is doomed to repeatedly revisit the problem.

Step 5: Standardize to Prevent Recurrence

Standardize means to put in a control system to prevent the problem from appearing again. Depending on the nature of the problem, this often requires management tools such as a revised maintenance schedule, revised standard operation procedures or visual work instructions, or process control charts. These preventative measures must be reviewed regularly to assure that the problem has been eliminated. During standardize you must

- Eliminate root causes
- Implement a permanent solution
- Confirm the effectiveness of the permanent solution
- Standardize the use of the new procedure

Kaizen Teams

Kaizen events that are conducted with cross-functional teams are powerful tools for process improvement. They allow the creativity of staff from across the organization to take a fresh objective look at where the organization stands. These teams often readily identify dozens of roadblocks and opportunities for improvement (OFIs). Teams working together inevitably generate ideas that do not arise in the normal daily operation.

> The best way to have a good idea is to have lots of ideas.
>
> **Linus Pauling**

A startling statistic that brings home the difference between Lean organizations and traditional organizations is the concept of idea generation. Typical American companies generate only 0.5 ideas per worker per year.* Typical Japanese companies generate nine ideas per employee per year.† Toyota generates 70 improvement ideas per worker per year![5]

Possible Target Areas for Kaizen Teams

Customer service: can be improved
Quality: can be improved
Costs: can be lowered
Schedule: improve delivery and production time
Cycle time, setup time: can be reduced
Inventory: reduce the unnecessary stock
Safety: reduce possible accidents
People: improve workers' skills and knowledge
Equipment: improve downtime and efficiency
Environment: improve air quality and reduce odors
Visual: use colors, clean up, and find things easier
Location: reduce unnecessary motion or facilitate necessary interaction, and so on

* "Small Business," *Encyclopedia of Business*, 2nd ed.
† Ibid.

Preparing for Kaizen

Preparing for a Kaizen event is almost more important than the event itself. Many events have failed to achieve results anticipated due to poor preparation. This can lead both management and staff to lose faith in an incredibly valuable tool. The basics of preparing for Kaizen include

Management selects target area: This should not be too broad or too narrowly focused. The examples provided earlier give some great topics for Kaizen.

Set time: Two- to five-day Kaizen events are typical. These can be followed by 6–8 weeks of continuous improvement team meetings to complete solutions implementations before disbanding the team and re-forming to attack another topic.

Set scope or project boundaries: The team needs to know what is included and what is off limits. This helps to keep focus and achieve better results.

Select Kaizen team members (4–6 cross-functional): These should include one to two employees from the target area, suppliers, and customers of the target area. For example, a Kaizen in manufacturing may want to include someone from order processing (supplier) and distribution (customer). Teams should also include at least two outsiders from different departments or functional areas.

Objective *eyes* assigned to project: This is typically an external consultant, but can be an internal source if there is a highly trained LSS practitioner on staff. One of the many advantages of using an external source is the wealth of project implementations he or she typically brings to your organization. Another is mentoring of team members during the event. Perhaps the most important role of an external consultant is the ability of the external person to expose sensitive weaknesses that employees may be reluctant to point out.

Team Member's Roles in Kaizen

Each team member's role is to work synergistically with other team members to improve the target area. When conducted correctly, Kaizen becomes contagious. It is the constant doing and sharing of Kaizen results that stimulates others to do Kaizen! Team members should remember to

- Participate
- Study the process in the target area
- Use creativity before capital
- Use Kaizen
- Share ideas
- Ask questions
- Experiment with changes

Overcoming Obstacles during Kaizen

The "we can't" syndrome is the common outcry of employees in traditional organizations. The list of reasons the authors have personally been given why Kaizen will not work in a particular organization is staggering. Once you begin your journey to becoming an LSS practitioner, you immediately realize how ridiculous all the following assertions are.

- We produce such a variety of products.
- Our products are custom; we cannot standardize.
- The change is too rapid.
- We are not in a mass production situation.
- Our people are too busy.

Some reasons for not conducting process improvement reach a level of absurdity that is difficult to comprehend. Let us share a true story with you that one of the authors experienced. Several years ago, we were conducting a process improvement program in a traditional organization with a management philosophy similar to the Theory X philosophy. The management team was tremendously cost driven in every aspect of their organization. One of our OFIs surfaced the need for additional employee training and cross-training. It was readily apparent to the entire team that employees at this organization were in dire need of training and cross-training. However, the very thought of spending money, time, energy, and effort on training and cross-training was out of the question for senior management. Management's response to the team was: "If we train them, they will leave the company."

From our perspective, this was understandable since it was blatantly obvious that senior managers were living one of the traditional belief philosophies of *low pay, high turnover*. So as to not be too confrontational, we posed a question to management. "Is there anything that you can think of that would be worse than trained employees leaving your company?" There

was a puzzled look on some faces as they were struggling to comprehend the question; clearly, it had not dawned on them that anything could be worse. After a few moments of silence, my response was, "The only thing worse than trained employees leaving the company is *untrained* employees that stay with the company."

Needless to say, process improvement programs did not get very far in that organization. Senior management held closely to their belief and completed nothing but the bare essentials of employee training. Even in the face of poor product quality and poor customer satisfaction, they were unwilling to change their beliefs and prepare their staff to deliver what the customer wanted. This is a message to all managers in all organizations that "beliefs drive behavior." Work daily on developing your LSS belief system.

So, whenever you are faced with the employee response *we can't* change for any reason, use the following response: "I know we can't do this because …, but if we could, how would we …?"

People sometimes fear change. I have been asked on several occasions, what if the Kaizen does not work? The answer is simple: Do Kaizen again! Yeah, but what if it still does not work? If it still does not work, do Kaizen again! What if a problem develops from a Kaizen? Do another Kaizen until the problem goes away! You need to conduct Kaizen until you reach a point where you have faith and have lost your fear of taking improvement actions. That is when you know that you are a change agent, a true LSS practitioner (see Figure 10.3).

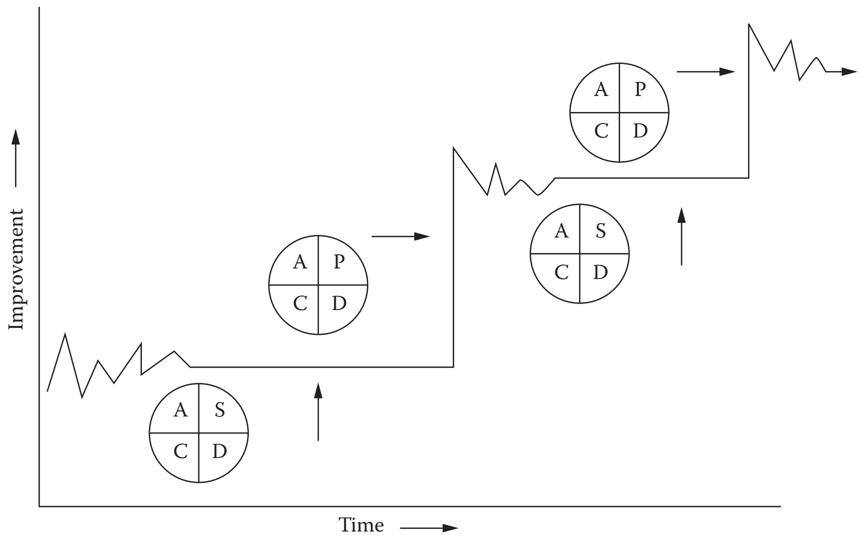

FIGURE 10.3
Ten attributes of Kaizen.

KAIKAKU: TRANSFORMATION OF MIND

Similar to Kaizen, Kaikaku has been defined in many ways. Several definitions follow to give you a range of interpretations of the term *Kaikaku*.[6]

1. Kaikaku: Change plus radical.
2. Kai: To take apart and make new. Kaku: Radically alter.
3. Kaikaku: Transformation of mind.
4. Kaikaku: Can also mean innovation, although the authors will discuss innovation later in this chapter as Kakushin.

How Do We Recognize Kaikaku (Transformation of Mind)?

Kaikaku is the result of successive Lean learning and Lean doing until Lean becomes a part of you. Looking back, I am not even sure when it first occurred in me. One day, I was training in an organization when it became clear to me that my mind was completely rewired with Lean beliefs and behaviors. Since that day, I have been on a mission to help employees at all levels transition from a traditional belief system to a Lean belief system.

In Kaizen, we talked about small incremental changes. Many of the tools presented in this handbook are used in Kaizen. Some, however, are tailored to Kaikaku in that they require a more complex set of activities, a more comprehensive set of Lean beliefs and behaviors, or simply put, a *transformation of mind* has taken place to properly deploy the Lean tool. This entire handbook is about trying to bring about this transformation of mind in all your employees.

The misconception of management in most Western companies is that Lean is just a set of tools. Management and employees learn a few Lean tools, conduct some Kaizen, and believe that their organization is Lean. Until the transformation of mind has occurred in employees at all levels, your organization cannot reap the true benefits of Lean.

It is only when an employee reaches a significant point in the Lean journey that he or she begins to recognize Kaikaku in himself or herself. Their own personal transformation of mind from traditional beliefs to Lean beliefs is occurring on a daily basis. Those in your organization still practicing traditional beliefs will neither recognize your efforts nor consider them to have any value. Do not let this deter you. You must continue on your journey and help them to see and live Lean beliefs and behaviors.

Two examples of Lean tools that can reflect the presence of Kaikaku are cell design and facility layout.

Kaikaku in Cell Design

Let us consider the five steps of cell design and some of the changes that have to occur to successfully implement a cell. Many changes to traditional beliefs about materials, people deployment, equipment, and methods of production need to be considered and include

- Grouping similar products
- Looking at customer demand and understanding how it changes
- Calculating customer demand
- Redeploying people in nontraditional roles (to meet customer demand, not fill a functional job description)
- Changing the number of people as needed
- Placing equipment to allow continuous materials flow during the value-added process
- Connecting the signals that initiate flow of materials to customer demand
- Using point of use storage (POUS) for materials and equipment whenever possible
- Using quality at the source
- Creating visual work instructions

Individually each of these attribute changes may not appear too significant; however, collectively they represent a radical change or transformation of mind. The Kaikaku case summary of a composite U-cell (discussed in detail in Chapter 4) demonstrates how this transformation of mind occurs collectively for a large number of employees working together in a cell.

Kaikaku in Facility Layouts

Over the years, we have heard many managers touting that they were implementing a Lean layout. However, if we take a closer look at these facilities, we find that few Lean tools had been successfully incorporated into the process. A true Lean facility layout requires that Kaikaku is present. Even more so than a single cell, an entire Lean facility layout is

composed of hundreds of considerations. The most important aspect is to begin with customer demand and configure your facility to respond to what your customer wants. Some of the major considerations are

- Assessing build-to-order and build-to-stock products
- Creating a mixed-model pull system
- Order processing
- Purchasing practices
- Inventory control
- All production activities
- Equipment layout
- Materials placement and POUS
- Employee deployment
- Distribution

One approach when considering a new facility layout is to complete a walk-through Lean layout. Figure 10.4 shows the results of a Lean facility layout project. Using only blue painter's tape and wood pallets, the team created a functional facility layout. The objective of the project was to produce a Lean layout design that allowed senior management to *walk through* the facility prior to any equipment or material delivery and physically see how the facility would operate in the new Lean mixed-model pull system. Locations for everything were identified on the facility floor. This included

FIGURE 10.4
New facility layout: walk-through design process.

raw materials POUS, all equipment, materials motion through the facility, employee deployment, production personnel offices, finished goods inventory, and ground, less than truckload and truckload distribution. From this simple layout, we could show management how materials would be received, where POUS would be, how orders would be processed on the floor, how employees would be deployed, electrical and other utilities considerations, and how order fulfillment would occur for distribution.

A true Lean facility layout requires a transformation of mind to complete effectively. How we think about materials handling, employee deployment, equipment utilization, and adding value for the customer all must be radically changed from those of a traditional organization. They require the adoption of so many small changes that at this point the organization has undergone a radical change in beliefs and about how value is created for the customer. At this point, the mental transformation has occurred and you are operating as a Lean organization.

KAKUSHIN (INNOVATION)

Virtually, all process improvement requires some form of change that could be described as innovation, or at a minimum, creativity. In this section, we look at innovation as a process in and of itself. As such, it can be defined, described, and managed like any other process. In the remainder of this section, we present the 20–20 innovation process.

The 20–20 Innovation Process

Organizations are focusing on innovation as the necessary skill for revenue growth in that most corporations have pretty much exhausted the opportunities for restructuring and reengineering. The new strategic mantra is revenue growth resulting from four primary strategies: (1) geographic expansion; (2) alliances, acquisitions, and mergers; (3) greater market penetration; and (4) product development and enhancement. And product development and enhancement ultimately depend on product development as their foundation. Market penetration literally depends on marketing innovation for its success, with product development and enhancement, along with cost advantages, contributing greatly. To obtain

cost advantages, an organization also depends on innovation, as process design and continuous improvement are process innovation activities. Finally, the related process of management innovation is an untapped resource that can help organizations improve the value that they add to the value chain of key organizational processes (see Figure 10.5).

To compete, organizations either attempt to differentiate themselves from their competitor or attempt to achieve some relatively low-cost position, and in both cases, innovation is the key journey from novice to expert in any field begins by understanding these essentials, practicing them, mastering them at one level, and then moving on toward the limits of your potential. At some point in the process, the best innovators rise above their profession in a multidisciplinary manner.

Each of the six essentials of the 20–20 innovation process represents a bundle of habits, skills, and knowledge that come together in innovation-driven, problem-solving personalities, and each personality draws its strengths from a variety of specialties. A select number has been identified and mapped against the six essentials as a basic guide to the interdisciplinary skill set, as shown in Table 10.1.

These six personalities serve as an effective way to assess yourself and your organization, so that you can determine what your strengths and weaknesses are and how to assemble a complete innovation and problem-solving capability. This approach should be considered a guide, not a magic formula, in that each individual and organization has a unique

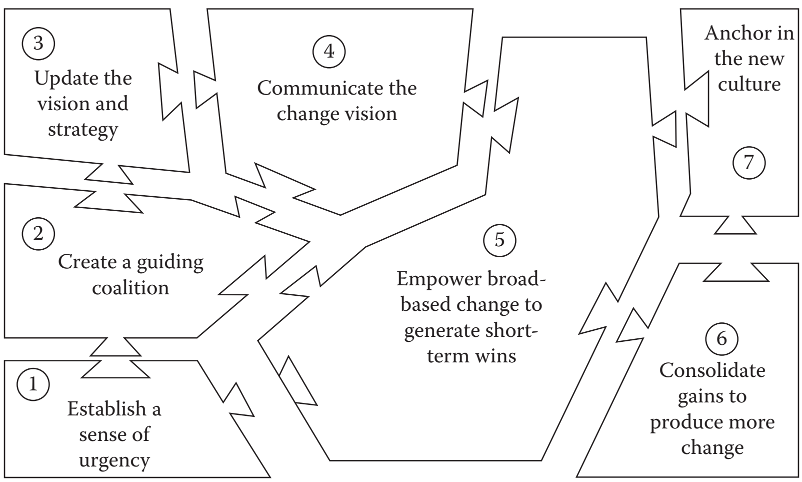

FIGURE 10.5
The 20–20 innovation process model.

TABLE 10.1

Six Essentials of the 20–20 Innovation Process

Six Essentials of Innovation	Essential Description	Related Innovation Personality	Personality Description (Likely Professional Source of Knowledge and Skill)
1. Generate the mindset	Creating organizations and teams that are innovative, creative, and decisive	The innovator	Visionary, designer, entrepreneur, artist, counselor, spiritual leader, poet
2. Know the territory	Acquiring and absorbing strategic knowledge on a continuous basis	The discoverer	Historian, scientist, researcher, journalist, investigator, teacher, accountant
3. Build the relationships	Building loyalty and trust by exchanging and delivering value	The communicator	Politician, social worker, civil servant or leader, legislator, publicist, salesperson, agent
4. Manage the journeys	Picking the right projects to work on, for the right reasons, at the right time, with the right tools	The playmaker	Commander, executive, physician, consultant, judge, coach
5. Create the solutions	Designing the best end-to-end solutions that are complete and well supported	The creator	Builder, architect, engineer, inventor, investor, author, trader
6. Deliver the results	Implementing solutions that are effective for complex and competitive situations	The performer	Athlete, attorney, entertainer, musician, nurse, customer representative

mixture of these skill sets that we use to feed into our *Knowledge Wizard* (KW). Some are intensively focused on one or two of these skill sets, and others have a broader blend—the greater the blend, the higher the probability of success. In other words, the better you get to know them, the better innovator and problem solver you will become. Great innovators know their strengths and weaknesses; they build teams to compensate for the weaknesses and create wholes that are synergistic in that they are greater than the sum of their individual parts.

At its basic fundamental level, all competition in some way relies on innovation and creativity. There are six essential innovation and problem-solving skills that apply to any type of innovation or opportunity. The difference between the best and the worst innovators and problem solvers lies in how many of these skills they can marshal by themselves and with others, and how deeply the skills are understood, both individually and collectively. Poor innovators understand them incompletely, and therefore cannot develop an effective and complete capability. Great innovators and problem solvers know them well enough to pull together and manage all six, or exhibit one in great depth, as part of a team. The following outlines in more detail the six essentials of the innovation process.

Essential 1: Generate the innovation mindset. Identify opportunities and potent ideas and attitudes for success and create a strategy for various alternative points of view, while defining the program expectations and metrics. This will improve your organization's effectiveness in moving creatively through the process and related problem-solving effort.

The innovator's mindset and central idea is that the best innovation comes from taking alternative points of view. They have a unique and flexible way of seeing things, and thus the ability to both develop original viewpoints and incorporate those of others around them, which are the roots of both creativity and objectivity. The innovator's journey is the sum of many different points of view. Tapping into these alternate perspectives of both ourselves and others, then testing them and choosing the most valuable, requires sustaining a flexible viewpoint through further inquiry. Our innovation quotient questionnaire helps to integrate these perspectives in new ways, which constitute the powerful mindset of the innovator.

The components of this first phase of *developing the mindset* are (1) developing potent ideas and attitudes using a project scope sheet, (2) turning problems into opportunities using the IQ assessment,

(3) committing to the challenge, (4) creating strength out of weakness and vulnerability, (5) not settling for half-measures, and (6) transcending the limits.

Essential 2: Know the territory. This stage concentrates on moving from innovation to insight by asking the right questions and obtaining sound and timely information and data. It also involves the collection and analysis of the system's past (using the KW).* Better knowledge helps organizations define the opportunities and problems more effectively, choose the better pathways, and clearly identify what is at stake. The discoverer's skill set helps to answer the following:

At this stage, we simply do not know enough to define the opportunity or problem well, so why don't we step back and answer some key unknowns before we proceed any further?

Although we may have a seemingly well-structured proposal, what have we really learned from our past mistakes in that area?

How can we avoid an unworkable journey or one that creates unnecessary risk?

The discovery process and knowledge of the territory bring insight and understanding, which often reveal the most likely problems and opportunities in the context of higher relief. By performing more investigation, the implications become more apparent as a foundation for action. Without this essential, the innovator may choose an unworkable journey or one that creates unnecessary risks. We need to remember that knowledge is the key asset of our day and age. Knowing the territory, the work of the discoverer using the KW deals with acquiring the right information about the critical elements of the environment that we are solving problems in.

Essential 3: Build the relationships. This stage involves the basics of how to move from insight to relationship building by cultivating quality communications and interaction, so that we can create an ever-expanding circle based on service, identity, and loyalty. It gives your organization the support and human context that is needed to effectively create and foster innovation and implement change. Good communicators probe the functions and contradictions to ask whether ideas and opportunities are really worth it.

* Knowledge Wizard® software, Ideation International, Inc.

- What will our customers and stakeholders think about this? Will our efforts add value and build loyalty?
- Are these opportunities going to threaten some of our best business relationships in the process, and are they really worth it?
- How will the people be affected by the opportunities?

Through the mastery of relationship building, good communicators connect potential journeys to their actual implications and contradictions for real people, to help determine whether the innovation or problem solving is worthwhile, for whom, and why. Then they generate a core group that will tackle the journey, along with a virtual network that will support the effort. The support network is key, as this is not a one-person brainstorm. Without this essential, there may be no compelling reason to innovate and solve the problem at all. Or worse yet, there may be a reason, but no one convinced enough to take part.

The components of this third phase of building the relationships are (1) cultivate quality communication and interaction, (2) create meaningful communication, (3) move from communication to give-and-take relationships, (4) advance from relationships to a core team, (5) the core team leads to a network, and (6) the network advances to a living community.

Essential 4: Manage the journeys. This stage focuses on moving from building the community to giving that core community a sense of direction and clear priorities by choosing destinations and strategies. The focus is on alignment and commitment to projects and chartering, along with defining how to pursue the selected directions and revealing evolutionary resources, that is, the technologies, materials, products, processes, skills, and knowledge that could be utilized in the development using the innovation knowledge base (which could include patterns describing the evolution of technological and social systems). Fostering the understanding of the stages of the innovation journey helps the organization set goals, define success, and develop effective plans. Playmakers are those who ask about alternatives and eliminations with the following questions:

- Although the ideas may be interesting, are we reaching high enough here?
- What is our real aim and purpose?

- The technology or tools may be great, but are we solving the right problem?

The components of this fourth phase of managing *the journeys* are (1) choose destinations and set directions; (2) solve the right problems at the right time by moving from disorientation to selection; (3) choose where you want to go, what to eliminate, and the paths to get there; (4) define success; (5) plan for the unexpected (chance) with alternative operators; and (6) lead the way.

Essential 5: Create the solutions. This stage involves moving from leadership to power by designing, building, and maintaining optimal solutions. It helps organizations to bring the best people and technology together, along with the necessary tools and software, to generate complete and flexible solutions for the innovations and problems that you are trying to solve. A good creator uses modeling to ask the following:

- Even if we have come up with a great idea, do we have the right people and the capability skill sets behind it?
- Do we really understand the purpose of our designs?
- Even if it is the right innovation area or problem to work on, are we willing to invest in the needed technology that it may take to deliver it?
- Do we really understand if the economics are viable and doable?

A key to this stage is revealing and solving problems using modeling, resolving contradictions, overcoming limitations, and so on that can hinder the achievement of set goals using various instruments for problem solving, including the most recent ideation DMADV methodology. It could also involve some objectives: deployment, customer needs, customer experience, measurements, and management reviews. The components of this fifth phase of creating the solutions are (1) design, build, and maintain optimal solutions using DMADV; (2) find the right people for the right work; (3) get the right tools to do the job to move from team to capability; (4) learn how to conserve scarce resources; (5) get the right information to the right people; (6) design solutions that evolve; and (7) shift the balance of power to create the dominant solution.

Essential 6: Deliver the results. This stage concentrates on moving from power to sustainable advantage through the stages of intuitive and disciplined implementation, which allows the organization to continually exceed expectations, and conquer complexity, scale, and friction. The key is performance, which is accomplished with simplicity, discipline, and a competitive advantage. This stage is all about performance, which uses the KW as the following questions illustrate:

- We may have a brilliant strategy, but can we execute and implement it?
- Are the timeframes and resources unrealistic?
- What are the biggest risks, and how can we manage them up front?

The components of this sixth phase of delivering the results are (1) practice intuitive, disciplined execution using the KW, (2) simplify and specify, (3) set the pace and pilot the course, (4) make the right decisions at the right time, (5) optimize risk and return, (6) learn to fail small and early on to win big later on, and (7) maintain your leading cutting edge.

SUMMARY

One of the few things that we know for certain is that change is constant in organizations. This change can come in many forms and can include positive or negative attributes for individuals, departments, and the company at large. This chapter was structured to give you approaches that drive structured positive change and provides a fundamental foundation for successful LSS process improvement projects.

First, we discussed the three primary obstacles or resistance-to-change factors that can inhibit effective LSS process improvements. The most common resistance-to-change factors are fear of the unknown, beliefs, and measurement systems. The LSS practitioner should be prepared to recognize and understand these obstacles and use LSS concepts and tools to overcome them.

The essence of this chapter is the concepts of Kaizen, Kaikaku, and Kakushin, which are the three fundamental tools or conduits to deploy change in your organization. With the application of Kaizen in each of

its common forms—Kaizen and You, Kaizen for process troubleshooting, and Kaizen teams—the LSS practitioner can become a driver of positive change with virtually all employee engagements. This can be assisting employees with small process improvement projects that each individual can complete on his or her own. The most widely known and used form is the Kaizen event or Kaizen continuous improvement team. Kaizen teams typically attack projects that are larger in scope than any one person can handle. These projects can be 2–4 days in length or can include team activities that can last several weeks.

The second fundamental concept and milestone is the transformation of mind concept, which reflects the LSS practitioners' advanced knowledge as exhibited by the use of multiple LSS tools in unison. The ability to think and act across the entire value stream has become a part of your organization's daily activities.

The third fundamental concept in this chapter is the systematic and standardized approach to change by innovation. The 20–20 innovation process demonstrates the six essentials of innovation that can be applied to LSS organizational improvements.

When employees begin to deploy the change management concepts presented in this chapter, a powerful positive set of changes emerge and the organization will begin systematically eliminating waste, improving processes, and expanding LSS knowledge for employees. These are the building blocks to improved product quality, increased employee productivity, and enhanced company profitability.

REFERENCES

1. Massaki Imai, Kaizen—The Key to Japan's Competitive Success, McGraw-Hill, Irwin, New York, 1986.
2. Massaki Imai, *Gemba Kaizen*, McGraw-Hill, New York, 1997.
3. William Bridges, *Managing Transitions*, 3rd ed., Da Capo Press, Cambridge, MA, 2009.
4. Imai, *Gemba Kaizen*, McGraw-Hill, NewYork, 1997.
5. Bunji Tozawa and Norman Bodek, *The Idea Generator—Quick and Easy Kaizen*, PCS, Inc., Vancouver, WA., 2001
6. Norman Bodek, *Kaikaku: The Power and Magic of Lean—A Study in Knowledge Transfer*, PCS Inc., Vancouver, WA., 2004

11

Lean Thinking 101

> The world we have created is a product of our thinking; it cannot be changed without changing our thinking.
>
> **Albert Einstein**

IN A NUTSHELL

Everyone should understand the philosophy behind *Lean* before going to detail. We know too many people (at all levels of the organization) who think Lean is using the tools, and they do not understand the idea behind it all; they just *visualize* or *standardize* the mess, worse yet, create islands of perfection in the sea of waste. Lean thinking shifts management concern away from assets and finance and focuses them on the perspective of the customer and the processes that they use to create value for the customer. Value is created when the supplier gives the customer exactly what they want, and when they want it. Lean thinking provides a foundation for identifying and eliminating waste, leaving only value-added processing for the customer. This is a conscious attempt to precisely define value in terms of a specific product with specific capabilities at a specific price through a dialogue with the customer. Managers need to rethink along product lines and not existing assets and technologies. In the 1980s, a massive paradigm shift occurred within the factories throughout the United States and Europe. Mass production and scientific management techniques from the early 1900s were jettisoned, whereas Japanese manufacturing companies demonstrated that *just-in-time* was a better and a more pragmatic approach. These widely adopted Japanese manufacturing concepts were refined by Toyota and came to be known as the Toyota Production System (TPS) or *Lean production*, which in time

led to the thinking behind it: Lean thinking. Eventually, the underpinnings behind Lean production spread to the office, then to logistics,* and from there to the military, to construction, and to the service industry. As it turns out, the principles of Lean thinking covered in this book are universal and have been applied successfully across many disciplines. Lean principles have proven not only to be universal, but to be universally successful at improving results.

OVERVIEW

The fundamental aspect of Lean thinking is managing the value stream. That means managing all activities required to create value for the customer. The value stream has three components: (1) product or service definition and development, (2) information management, and (3) operations management. Analyzing the value stream exposes waste by identifying many steps that create no value and should be immediately eliminated. How does so much waste go undetected in your organization for such a long time? First, most employees do not know how to see this waste. They have organizational cataracts that inhibit them from seeing waste as it truly exists. Second, departments are not accountable nor are they tasked to deeply understand their processes or explain their products, processes, or services to others. Finally, the matter of current organizational beliefs circumvents the desire to continually improve and reexamine process and product.

Lean thinking and value stream management are more efficient than batch processing. Batch processing is the culture of the farmer (i.e., you grow a lot of things and hope that someone will buy them). The farmer culture has been replaced by the hunter culture. The hunter culture is more efficient, as it seeks to "build what the customer wants when the customer wants it" or in other words *on-demand production*. On-demand production destroys the need for forecasting and lets the customer pull the product from the producer when needed. Lean thinking can cut production times by 90% and reduce inventories by 90%. Conversely, batch processing or mass production thinking results waste across the

* For details on the application of these principles to the logistics chain, see Macro Logistics Management, by Frank Voehl and Martin Stein, CRC Press, 1997.

organization, separating you from the customer, which ultimately leads to stagnant processes, indiscriminant cost cutting, and innovation incentive killing.

A Lean thinking approach means analysis of product or service flow. The manufacturing process is divided into process steps. Each step represents one or more sequence of assembly and transformation processes. A tub, for example, is passed between each step and triggers a series of events or activities. The parts associated with the tub are built exactly and immediately. Any process or resource that does not contribute value to the flow is removed. Along the entire cell, quality is built in at each process step, where cell team members constantly analyze the flow for defects and workers in the cell are allowed to respond and communicate problems and suggestions for improvement.

Another critical aspect of Lean thinking is establishing a pull system that begins with the customer demand. Customers pull products from the producer and remove the need for forecasting and excessive inventory size. Machines are equipped with fast transforming technology allowing for a diverse combination of assembled options for parts and products moving through product-specific cells. Lean thinking is better than materials resources planning (MRP) in that it eliminates the waste caused by forecast planning. Lean thinking removes the slack time in scheduling errors and the miscalculations in forecasted quantity amounts and types.

Applying Lean thinking to all aspects of product creation and delivery removes any flow restriction issues associated with getting the correct product to the customer, quickly, accurately, and efficiently. Lean thinking also replaces mass production process engineering and exposes process weaknesses of factories that have tolerated and managed these failures as a part of the mass production cycles.

Manufacturing perfection is impossible; however, thinking about perfection from the customer standpoint leads to inspiration and innovative solutions. Lean thinkers bring abundance of creativity and innovation to the market, transform nonstandard products into standardized products, and increase product or service value for the customer. The fundamentals of Lean thinking are continuous improvement in quality, design, and product.

A strong case can be made that these principles can reduce waste and costs, reduce lead times, and improve quality and resource utilization. This book is more than a practical guide. It also covers the somewhat *warm and fuzzy* aspects aimed at top execs and business strategists,

along with the Handbook applications designed for plant, production, and manufacturing managers.

Lean thinking is directed at making systematic incremental changes on your shop floor despite heavy production demands, or dealing with a union that is not willing to concede the initial layoff without a massive war, or despite typical day-to-day company crises. At a client plant site, when Japanese consultants were called in to implement Lean changes in a plant, they began taking machinery apart and moving it by themselves, piece by piece. At many plants we have seen, if a foreign consultant were to do that, they would probably be shot before they made it out of the parking lot.

Lean thinking has consistently fostered new innovations focused on meeting customer needs. The idea of delivering packages overnight was novel when Federal Express was started in 1971. In 1983, a new company called Lens Crafters changed the basis of competition in the eyeglasses industry by assembling prescription glasses in an hour. The concept of shipping products the same day they were ordered was a breakthrough concept when L. L. Bean upgraded its distribution system in the late 1980s. Southwest Airlines, one of the few profitable airlines these days, saves a lot of money with its unorthodox method of assigning seats as people arrive at the airport. In the 1990s, Dell maintained profitability in a cutthroat market by manufacturing to order in less than a week. Another Austin company builds custom homes in 30 days.

The common denominator behind these and many other industry-changing success stories is *Lean thinking*. Lean thinking looks at the value stream and asks: How can things be structured so that the enterprise does nothing but add value, and does that as rapidly as possible? All the intermediate steps, all the intermediate time, and all the intermediate expense are eliminated. All that is left are the time, the people, and the activities that add value for the customer.

Origins of Lean Thinking

Lean thinking got its name from a 1990s best seller called *The Machine That Changed the World: The Story of Lean Production*.[1] This book chronicles the movement of automobile manufacturing from craft production to mass production to Lean production. It tells the story of how Henry Ford standardized automobile parts and assembly techniques, so that low-skilled workers and specialized machines could make cheap cars for

the masses. The book goes on to describe how mass production provided cheaper cars than the craft production, but resulted an explosion of indirect labor: production planning, engineering, and management.

Then the book explains how a small company sets its sights on manufacturing cars for Japan, but it could not afford the enormous investment in single-purpose machines that seemed to be required. Nor could it afford the inventory or large amount of indirect labor that seemed necessary for mass production. So it invented a better way to do things, using very low inventory and moving decision making to production workers. Now this small company has grown into a large company, and the TPS has become known as *Lean production*.

> The mass-producer uses narrowly skilled professionals to design products make by unskilled or semiskilled workers tending expensive, single-purpose machines. These churn out standardized products at high volume. Because the machinery costs so much and is so intolerant of disruption, the mass-producer adds many buffers—extra supplies, extra workers, and extra space—to assure smooth production…. The result: The customer gets lower costs but at the expense of variety and by means of work methods that most employees find boring and dispiriting.[1]

A follow-up book called *Lean Thinking* tightened and narrowed the focus toward the conceptual side.* This book provides many case studies of companies outside the auto industry that converted to Lean production. It details the personnel changes they had to make, changes in factory layout, differences in the supply chain, and much more. Whereas *The Machine* That *Changed the World* was a primer to Lean production, *Lean Thinking* (by the same authors, Womack and Jones) is more of a how-to book. Together, they make a great pair and provide a fairly in-depth view of the subject. As in *The Machine That Changed the World*, there is plenty of hard data to back up the claims that these companies improved after switching to Lean thinking.

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* *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*, by Womack and Jones. *Lean Thinking* is the second of the Lean books from Womack and Jones. It picks up where *the machine* left and tries to abstract the learning from the machine into five values of Lean. The five values are *value, value stream, pull, flow, and perfection*. By abstracting these values, Womack and Jones enable the Lean manufacturing ideas to be used in different industries, which is exactly what happened. That makes this book a landmark book that may change the world even more than their first book. The book is good and very easy to read. The authors get to the point, their explanation is clear, and their stories make the book enjoyable. All in all, this is an excellent book and an absolute must read for anyone interested in Lean thinking, in whatever industry.

One of our clients is Pratt and Whitney, and we paid a recent visit to the plant described in the *Lean Thinking* book. We were absolutely in awe of the changes they made, their ability to integrate Kaizen for 5 years into the way they run the business, and the comparison between the *Chaku Chaku* line (the new grinding machines and flow) and the older Boehm machines. As we reflected on it, the book came to life. These stories are real and Lean thinking does make a difference. Lining up the value-creating activities into a value stream focusing on what the customer really wants has many benefits. One such Lean thinking approaches is described in *The 2,000 Percent Solution* by Mitchell, Coles, and Metz as the ideal or theoretical best practice. This is one of the steps in the master eight-step problem solving process described in their book. It allows you to think about the best way to do a task or reach a goal, with no resource constraints or old baggage, knowing what you know now. People report that once they develop their *Ideal Best Practice*, they can find a way to get there, rapidly, with greater benefits and at less cost.

Lean thinking is clearly part of the 2000 percent solution for many activities. Think of the centralized eyeglasses laboratory. Remember that Sears used to take 2 or 3 weeks to fill orders from its once-popular catalog. Recall the long distribution channel that used to be standard in the computer market. Think dinosaurs. Centralized equipment, huge distribution centers, and lengthy distribution channels were created to realize economies of scale. They are the side effects of mass production (i.e., symptoms of waste created in mass production), passed on through the supply chain or on to other industries. What people tend to overlook is that mass production creates a tremendous amount of work that does not directly add value. Shipping eyeglasses to a factory for 1 hour of processing adds more handling time by far than the processing time to make the glasses. Adding retail distribution to the cutthroat personal computer industry means that a manufacturer needs 6 weeks to respond to changing technology, instead of 6 days. Sears' practice of building an inventory of mail orders to fill meant keeping track of stacks of orders, not to mention responding to innumerable order status queries and constant order changes.

> The lean producer, by contrast, combines the advantages of craft and mass production, while avoiding the high cost of the former and the rigidity of the later.… Lean production is 'lean' because it uses less of everything compared with mass production – half the human effort in the factory,

> one forth the manufacturing space, one tenth of the lead time, half the investment in tools, half the engineering hours to develop a new product in half the time. Also, it requires one forth the inventory on site, results in many fewer defects, and produces a greater and ever growing variety of products.*

Dell Lean Thinking Journey

In the late 1990s, while on a tour of a large customer Michael Dell saw technicians customizing new Dell computers with their company's *standard* hardware and software.[2] "Do you think you guys could do this for me?" Dell's host asked. Without missing a beat, Michael replied, *Absolutely, we'd love to do that.* Within a couple of weeks, Dell was shipping computers with factory-installed, customer-specific hardware and software. What took the customer an hour could be done in the factory in minutes, and furthermore, computers could be shipped directly to end users rather than making a stop in the corporate IT department. This shortening of the value chain is the essence of Lean thinking.

Companies like Dell that have learned to rethink the value chain and find ways to provide what their customers value with significantly fewer resources than their competitors very often can develop an unassailable competitive advantage. Sometimes competitors are simply not able to deliver the new value proposition outlined, many have tried to copy the original Dell; few have succeeded. Sometimes the industry follows the leader, but it takes time.

Microsoft® Weighs In

In the mid-1990s, Microsoft® implemented corporate-wide financial, purchasing, and human resource packages linked to data warehouses, which can be accessed via web front ends. Each was implemented by "a handful of seasoned IT and functional experts … (who got) the job done in the time it takes a … committee to decide on its goals." In each of these examples, the focus of software development was on rapid response to an identified need. Mechanisms were put in place to dramatically shorten the time from problem recognition to software solution. You might call it *just-in-time* software development.[3] The question is why isn't all software developed quickly.

* Ibid.

The answer is rapid development must be considered important before it becomes a reality. Once speed becomes a value, a paradigm shift has to take place, changing software development practices from the mass production paradigm to Lean thinking.

If your company writes reams of requirement documents (equivalent to inventory), spends hours upon hours tracking change control (equivalent to order tracking), and has an office that defines and monitors the software development process (equivalent to industrial engineering), you are operating with mass production paradigms. Think Lean and you will find a better way.

Basic Values and Principles of Lean Thinking

There are five values and four principles of Lean thinking. The five values are (1) value, (2) value stream, (3) pull production, (4) continuous flow, and (5) perfection. The five key Lean values are defined as follows:

Value: "The inherent worth of a product as judged by the customer and reflected in its selling price and market demand. The value in a typical product is created by the producer through a combination of actions, some of which produce value as perceived by the customers and some of which are merely necessary given the current configuration of the design and production process. The objective of Lean Thinking is to eliminate the latter class of activities while preserving or enhancing the first set."*

Value Stream: "All of the actions, both value-creating and nonvalue-creating, required to bring a product from concept to launch (also known as the development value stream) and from order to delivery (also known as the operational value stream). These include actions to process information from the customer and actions to transform the product on its way to the customer."†

Pull Production: "A method of production control in which downstream activities signal their needs to upstream activities. Pull production strives to eliminate overproduction and is one of the three

* The Five Principles and Values of Lean Workshop, July 15, 2008, NetworkingMFG.com, Trox USA, Inc, Moderator Othmar Furer, Discussion Notes.

† Ibid.

major components of a complete just-in-time production system. In pull production, a downstream operation, whether within the same facility or in a separate facility, provides information to the upstream operation, often via a Kanban card, about what part or material is needed, the quantity needed, and when and where it is needed. Nothing is produced by the upstream supplier process until the downstream customer process signals a need. This is the opposite of push production."[*]

Continuous Flow: "Producing and moving one item at a time (or a small and consistent batch of items) through a series of processing steps as continuously as possible, with each step making just what is requested by the next step. Continuous flow can be achieved in a number of ways, ranging from moving assembly lines to manual cells. It also is called one-piece flow, single-piece flow, and make one, move one."[†]

Perfection: "When a process provides pure value, as defined by the customer, with no waste of any sort."[‡]

Dreaming about Perfection

It is easy to talk about perfection. But what does perfection look like? What common set of activities drive the *dreams* about how we would operate if we were truly Lean … to make them become a reality? Not just by implementing various tools and techniques but by truly revolutionizing them from the perspective of the customer. This will really drive home what breakthrough concepts or paradigm shifts look like.

Apple and Perfection

Is Apple perfect? Probably not. However, Apple epitomizes a critical aspect of Lean thinking by creating product flexibility to meet customer demand or more importantly the customers rapidly changing idea of value. Apple's iPhone and iPad, for example, may represent the ultimate in flexibility to customers' as yet unknown idea of value. Hundreds, perhaps thousands of

[*] Ibid.
[†] Ibid.
[‡] Ibid.

App writing individuals are constantly creating new and innovative Apps to meet Apple's customers' needs. This has got to be one of the most ingenious inventions in the history of inventions. Apple creates a product and some basic new innovative apps. Then proceeds to tap the brain power of an army of creative and innovative individuals from across the globe to do the critical component of product development and create value-added Apps for its iPad and iPhone users. Not all companies can be Apple; however, all companies can look at the fundamental activities that lead to Apple-type success.

Basic Principles of Lean

There are four basic principles of Lean thinking, which are relevant to most organizations:

1. Identify value from the customer standpoint (eliminate waste)
2. Center on the people who add value
3. Flow value from demand (delay commitment)
4. Optimize across organizations

Add Nothing but Value (Eliminate Waste)

The first step in Lean thinking is to understand what value is and what activities and resources are absolutely necessary to create that value. Once this is understood, everything else is waste. Because no one wants to consider what they do as waste, the job of determining what value is and what adds value is something that needs to be done at a fairly high level. Let us say you are developing an order tracking system. It seems like it would be very important for a customer to know the status of their order, so this would certainly add customer value. But actually, if the order is in house for less than 24 hours, the only order status that is necessary is to inform the customer that the order was received, and then that it has shipped, and let them know the shipping tracking number. Better yet, if the order can be fulfilled by downloading it on the web, there is really no order status necessary at all.

To develop breakthroughs with Lean thinking, the first step is learning to see waste. If something does not directly add value, it is waste. If there is a way to do without it, it is waste.

Center on the People Who Add Value

Almost every organization claims its people are important, but if they truly center on those who add value, they would be able to say that they are people doing the work who are the center of

Resources
Information
Process design authority
Decision making authority
Organizational energy

In mass production, tasks are structured so that low-skilled or unskilled workers can easily do the repetitive work, but engineers and managers are responsible for production. Workers are not allowed to modify or stop the line, because the focus is to maintain volume. One of the results of mass production is that unskilled workers have no incentive to volunteer information about problems with the manufacturing line or ways to improve the process. Maladjusted parts get fixed at the end of the line; a poor die or improperly maintained tool is management's problem. Workers are neither trained nor encouraged to worry about such things. According to Taichii Ohno, the Lean plant can be described as follows:

> The truly lean plant has two key organizational features: It transfers the maximum number of tasks and responsibilities to those workers actually adding value to the car on the line, and it has in place a system for detecting defects that quickly traces every problem, once discovered, to its ultimate cause.[4]

Similarly in any Lean enterprise, the focus is on the people who add value. In Lean enterprises, traditional organizational structures give way to new team-oriented organizations, which are centered on the flow of value, not on functional expertise. For example, the first experiment Taiichi Ohno undertook in developing Lean production was to figure out a way to allow massive, single-purpose stamping machines to stamp out multiple parts. Formerly, it took skilled machinists hours, if not days, to change dies from one part to another. Therefore, mass production plants had many single purpose stamping machines in which the dies were

almost never changed. Volume, space, and financing were not available in Japan to support such massive machines, so Ohno set about devising simple methods to change the stamping dies in minutes instead of hours. This would allow many parts of a car to be made on the same line with the same equipment.

Since the workers had nothing else to do while the die was being changed, they also did the die changing, and in fact, the stamping room workers were involved in developing the methods of rapid die changeover. Ohno transferred most of the work being done by engineers and managers in mass production plants to the production workers. He grouped workers in small teams and trained the teams to do their own industrial engineering. Workers were encouraged to stop the line if anything went wrong, (a management job in mass production). Before the line was restarted, the workers were expected to search for the root cause of the problem and resolve it. At first the line was stopped often, which would have been a disaster at a mass production plant. But eventually the line ran with very few problems, because the assembly workers felt responsible to find, expose, and resolve problems as they occurred. Centering on the people who add value means upgrading the skills of people through training and apprenticeships. It means forming teams that design their own processes and address complete problems. It means that staff groups and managers exist to support operations, not to tell them what to do.

Flow Value from Demand (Delay Commitment)

The idea of flow is fundamental to Lean thinking. If you do nothing but add value, then you should add the value in as rapid a flow as possible. If this is not the case, then waste builds up in the form of inventory, transportation, extra steps, or wasted motion. The idea that flow should be *pulled* from demand is also fundamental to Lean production. *Pull* means that nothing is done unless and until a downstream process requires it. The effect of pull is that production is not based on forecast; commitment is delayed until demand is present to indicate what the customer really wants. The concept of customer demand pulling continuous flow through the value-added process can be one of the easiest ways to visualize and implement Lean principles, as L. L. Bean, Lens Crafters, and Dell found out.

The idea is to fill each customer order immediately. In mass production days, filling orders immediately meant building up lots of inventory in anticipation of customer orders. Lean production changes that. The idea is to be able to make the product so fast that it can be made to order. True, Dell and Lens Crafters and L. L. Bean and Toyota have to have some inventory of subassemblies waiting to be turned into a finished product at a moment's notice. But it is amazing how little inventory is necessary, if the process to replenish the inventory is also Lean. A truly Lean distribution channel only works with a really Lean supply chain coupled to very Lean manufacturing.

The *batch and queue* habit is very hard to break. It seems counterintuitive that doing a little bit at a time at the last possible moment will give faster, better, and cheaper results. But anyone designing a control system knows that a short feedback loop is far more effective at maintaining control of a process than a long loop. The problem with batches and queues is that they hide problems. The idea of Lean production is to expose problems as soon as they arise, so they can be corrected immediately. It may seem that Lean systems are fragile, because they have no padding. But in fact, Lean systems are quite robust, because they do not hide unknown, lurking problems and they do not pretend they can forecast the future.

In addition to rapid, just-in-time information flow, Lean service means rapid, just-in-time delivery of value. In manufacturing, the key to achieving rapid delivery is to manufacture in small batches pulled by a customer order. Similarly in systems development, the key to rapid delivery is to divide the problem into small batches (increments) pulled by a customer story and customer test. The single most effective mechanism for implementing Lean production is adopting just-in-time, pull-from-demand flow. Similarly, the single most effective mechanism for implementing Lean systems is delivering increments of real business value in short time-boxes.

Optimize Across Organizations

Quite often, the biggest barrier to adopting Lean practices is organizational. As products move from one department to another, a big gap often develops, especially if each department has its own set of performance measurements that are unrelated to the performance

measurements of neighboring departments. For example, let us say that the ultimate performance measurement of a stamping room is machine productivity. This measurement motivates the stamping room to build up mounds of inventory to keep the machines running at top productivity. It does not matter that the inventory has been shown to degrade the overall performance of the organization. As long as the stamping room is measured primarily on machine productivity, it will build inventory. This is what is known as a suboptimizing measurement, because it creates behavior that creates local optimization at the expense of overall optimization.

Suboptimizing measurements are very common, and overall optimization is virtually impossible when they are in place. One of the biggest suboptimizing measurements in quality systems development occurs when project managers are measured on earned value. Earned value is the cost initially estimated for the tasks that have been completed. The idea is that you had better not have spent any more than you estimated. The problem is that this requires a project manager to build up an inventory of task descriptions and estimates. Just as excess inventory in the stamping room slows down production and degrades over time, the inventory of tasks required for earned value calculations gets in the way of delivering true business value and also degrades over time.

Nevertheless, if there is an earned value measurement in place, project tasks are specified and estimated, and earned value is measured. When it comes to a choice between delivering business value and earned value (and it often does), earned value usually wins out. To avoid these problems, Lean organizations are usually structured around teams that maintain responsibility for overall business value, rather than intermediate measurements such as their ability to speculate and pad estimates. Another approach is to foster a keen awareness that the downstream department is a customer, and satisfying this internal customer is the ultimate performance measurement. The paradigm shift that is required with Lean thinking is often hindered if the organization is not structured around the flow of value and focused on helping the customer pull value from the enterprise.

Extraordinary productivity gains in the production network or *value chain* are possible when companies are willing to collaborate in unique ways, often achieving competitive advantage by sharing resources, knowledge, and assets. Today, competition occurs between value chains and not simply between companies.

REFERENCES

1. James P. Womack, Daniel T. Jones, and Daniel Roos, *The Machine That Changed the World: The Story of Lean Production*, Rawson and Associates, New York, 1990.
2. Michael Dell and Catherine Fredman, *Direct from Dell*, Harper Business, New York, 1999, p. 159.
3. Robert J. Herbold, "Inside Microsoft: Balancing Creativity and Discipline," *Harvard Business Review*, January 2002, Vol. 1, pgs. 72–79.
4. Taiichi Ohno, *Workplace Management, 100th Birthday Edition*, McGraw-Hill, New York, 2013, p. 79.

12

Integrating Lean Management with DMAIC/DMADV

IN A NUTSHELL

Lean and Define, Measure, Analyze, Improve, Control (DMAIC)/Define, Measure, Analyze, Design, Verify/Validate (DMADV) (Six Sigma) are two fundamentally different approaches to process improvement. They are very effective tools to be applied when the circumstances call for either one. Lean's objective is to identify and eliminate waste in all processes, whereas DMAIC/DMADV's is to identify and eliminate variation in a process.

With Lean, waste is identified and classified into one of nine categories: (1) overproduction, (2) waiting, (3) defects, (4) motion, (5) transportation, (6) inventory, (7) underutilized employees, (8) extra processing, and (9) human behavior.

With DMAIC/DMADV, tollgates are process checkpoints where deliverables are reviewed and measured, and readiness to move forward is assessed. An effective tollgate review is a two-way, fact-based dialogue that is central to running and improving a business. Although leaders do not have to work the mechanics of the Six Sigma tools, they need considerable savvy in the reading and interpretation of each tool's outputs. Those who prepare well in this area are able to expect teams to use certain tools to answer certain kinds of questions (thereby driving the proper use of tools). Their understanding helps them to challenge some team findings, to coach teams that may get stuck or off track, and to anticipate the tools and data that will be useful in an upcoming review.

Integrating Lean with DMAIC/DMADV can offer the best of both worlds for process improvement practitioners and Lean management developers, to understand the strengths of each and integrate them effortlessly where applicable.

OVERVIEW

Integrating the *identifying and eliminating waste* concepts of Lean with the *identifying and eliminating variation* concepts of DMAIC/DMADV has been difficult to the process improvement community. In fact, even today, there remains poor understanding of how to make both of these excellent tools work in unison. Lean and DMAIC/DMADV show the individuality of each approach, and the complimentary nature of these two unique and specific approaches together make a powerful process improvement philosophy.

The goals of Lean, can and do use some quantification, however, the Lean philosophy is predominantly qualitative in nature. This overarching qualitative approach puts a few core beliefs above all activities. In fact, all activities should be traceable back to one of the following qualitative business drivers: (1) all activities are driven by customer demand, (2) establishing continuous flow of products or services to meet these customer needs, and (3) driving waste out of the process until the customer receives perfection as a result of your efforts.

The goals of DMAIC/DMADV and the Lean management system (LMS) are rooted in quantitative analysis and the scientific method. In the *Science for All Americans*, the authors, Rutherford and Ahlgren, note: "Scientific habits of mind can help people in every walk of life to deal with problems that often involve evidence, quantitative considerations, logical arguments, and uncertainty … involving four key values: curiosity, openness to new ideas, skepticism, and critical thinking. Curiosity means being filled with questions, seeking answers, and verifying how good the answers are. Openness means being discovery-oriented, even if the ideas are at odds to what is currently believed. Skepticism means accepting new ideas only when they are borne out by the evidence and logically consistent. Critical thinking means not being swayed by weak arguments." Collectively, these four key values represent the foundation for scientific thinking as applied to the house of Lean management.

Some of the difficulties that arise in applying the scientific thinking principles to Lean management are the following:

- Overcoming resistance to change even when an innovative change is suggested as it is difficult to get people to try the change and adapt themselves to the new situation.
- Satisfying a diversity of viewpoints as different team members may have varying viewpoints as to what constitutes an improvement.
- Thinking that any change using the DMAIC/DMADV process would be an improvement in its own right.
- Taking the time to integrate the objectives of the problem-solving process with the LMS, once the change is agreed to.
- Recognizing when a change is an improvement through proper testing and follow-through.

Although the above-mentioned difficulties are real, they can be overcome by using the DMAIC/DMADV problem-solving process outlined in this application and by helping people overcome the roadblocks, which is the true focus of the science and art of this approach. Because all products, services, and outcomes result from a complex system of interaction of people, equipment, and processes, it is crucial to understand the properties of such systems. Appreciation of the DMADV design and verification process helps us to understand the interdependencies and interrelationships among all of the components of a system and thereby increases the accuracy of prediction and the impact of recommended changes throughout the system. However, a person can use the methods described in this application without knowing the theory behind them, just as a person can learn to drive a car without knowing how it moves. Dr. Edwards Deming once said that one need not be eminent in any part of scientific thinking to understand and apply it.

GOALS OF LEAN MANAGEMENT

The goals of a Lean organization has its roots in Lean manufacturing, a comprehensive term referring to manufacturing methodologies based on maximizing value and minimizing waste in the manufacturing process. Lean manufacturing evolved in Japan from its beginning in Ford Motor Company. Toyota builds on Henry's concepts for the elimination of waste

and just-in-time stocking to create the Toyota Production System in Japan. Many of the most recognizable phrases, including Kaizen and Kanban, are Japanese terms that have become standard terms in Lean manufacturing and in the past 10 years or so have rapidly spread to the service, government, military, and not-for-profit sectors.

At the heart of Lean goal-setting is the determination of value. Value is defined as an item or feature for which a customer is willing to pay. All other aspects of the manufacturing or service delivery process are deemed waste. Lean manufacturing is used as a tool to focus resources and energies on producing the value-added features while identifying and eliminating nonvalue-added activities.

In addition to the goals for products or services, individuals may set goals to achieve a personal objective such as career advancement. This section introduces a sequential process for setting goals. It describes a process based on SMART (Specific, Measurable, Achievable, Realistic, Time framed) for developing and implementing goals.

Specific: Goals need to be something specific. Often we set goals that are so loose. It is nearly impossible to judge whether we hit them or not. For example, a statement like "I will lose weight" is too vague. How will you know if and when you have reached your goal? Saying, "I will lose five pounds this month" is more specific. At the end of the month, it will be a simple matter of weights and measures: take your measurements and get on the scale.

Measurable: Goals need to be measurable. For example, many of us want to increase our number of contacts. But, "making new contacts" is an ambiguous statement. A clearer objective is "I will attend four networking events each month and try to connect with one person at each." It is a simple, concrete goal. This makes it easy to see if you hit your target.

Achievable: Goals need to be reasonable and achievable. Nearly everyone has tried to drop a few pounds at one time or another. Often their success or failure depends on setting practical goals. Losing 15 lb in 30 days is unrealistic (unless you are planning a medical procedure). Losing 6–8 lb in 30 days is reasonable. Do not set yourself up for failure by setting goals that are out of reach.

Realistic: Goals need to be realistic. When we are kids, we think we can do anything. As adults, we learn that while we can have a lot, we cannot have it all at the same time. It is important to honestly evaluate

yourself. Do you have the ability and commitment to make your dream come true? Or does it need a little adjustment? For example, you may love to play tennis, but do you have the time, talent, and commitment to become a pro? Be honest. The other side of the story is do not set goals that are easy to reach. Set goals that stretch you to achieve something different. Too many people or organizations set goals that do not challenge them. It is better to set a goal of improving 20% and only improve 15%, than to set a goal of 5% improvement and only do 8%. Your goals should challenge you to find a better way.

Time framed: Goals need to have a time frame. Having a set amount of time will give your goals structure. For example, many of us want to find a new job or start their own business. Some people spend a lot of time talking about what they want to do, someday. But, without an end date, there is no sense of urgency, no reason to take any action today. Having a specific time frame gives you the impetus to get started. It also helps you monitor your progress.

For the purposes of this chapter, a goal is a statement of a desired future an organization wishes to achieve. It describes what the organization is trying to accomplish. Goals may be strategic (making broad statements of where the organization wishes to be at some future point) or tactical (defining specific short-term results for units within the organization). Organization goals serve as an internal source of motivation and commitment and provide a guide to action as well as a means of measuring performance.

Defining organizational goals helps to conceptualize and articulate the future direction of the organization, thus allowing those responsible for setting that direction to develop a common understanding of where the organization is heading. Goals provide a way of letting the total staff know where the organization wants to go. The key goals of the Lean organization consist of four areas:

1. *Quality* is the ability of the organization's programs, products, and services to conform to the customer's requirements, wants and needs as stated earlier. An initiative executed in a quality manner is celebrated much longer than one that is facilitated with mediocrity.
   a. Improve quality
   b. Eliminate waste

   c. Reduce lead time
   d. Reduce total cost

2. *Elimination* of waste means removing any activity that takes up extra time, resources, or space and adds no value to the programs, products, or services that are being given the focus.
3. *Reduced lead time* means reducing the total time it takes to complete a series of tasks within a process. By reducing the lead time, an organization can quickly respond to changes in customer demand and requests while improving on its return on investment (ROI).
4. *Reducing total costs* means reducing the direct and indirect costs associated with production and delivery of programs, products, or services. To reduce its total costs, an organization must eliminate and reduce lead times. But, the first step is to understand what those actual direct and indirect costs really are. Hence, a starting point.

GOALS OF DMAIC/DMADV LEAN MANAGEMENT SYSTEMS

The goals of DMAIC, DMADV, and LMS alike are based on certain common systematic quantitative approaches to process improvement, process design, and measurement system analysis, respectively. The basic structure and goals of these approaches is focused on identification and elimination of variation and waste both in process design and in process improvement, especially in relation to the creation of an LMS. The basic idea is to *Lean* the system first, before implementation, rather than later, after the fact.

In a Lean Management System, the DMAIC process can be clarified and explained as follows:

- *Define:* Select an appropriate project and define the problem, especially in terms of customer-critical demands.
- *Measure:* Assemble measurable data about process performance and develop a quantitative problem statement.
- *Analyze:* Analyze the causes of the problem and verify suspected root cause(s).
- *Improve:* Identify actions to reduce defects and variation caused by root cause(s) and implement selected actions, while evaluating the measurable improvement (if not evident, return to step 1).
- *Control:* Control the process to ensure continued, improved performance and determine if improvements can be transferred elsewhere. Identify lessons learned and next steps.

Recap of How DMAIC Works

The tools of process improvement are most often applied within a simple performance improvement model known as DMAIC. DMAIC is summarized in Figure 12.1. DMAIC is used when a project's goal can be accomplished by improving an existing product, process, or service.

DMAIC is such an integral part of Six Sigma that it is used to organize the material for part II of the *Six Sigma Handbook*. It provides a useful framework for conducting Six Sigma projects (see Figure 12.2). DMAIC

D **Define** the goals of the improvement activity. The most important goals are obtained from customers. At the top level the goals will be the strategic objectives of the organization, such as greater customer loyalty, a higher ROI or increased market share, or greater employee satisfaction. At the operations level, a goal might be to increase the throughput of a production department. At the project level goals might be to reduce the defect level and increase throughput for a particular process. Obtain goals from direct communication with customers, shareholders, and employees.

M **Measure** the existing system. Establish valid and reliable metrics to help monitor progress towards the goal(s) defined at the previous step. Begin by determining the current baseline. Use exploratory and descriptive data analysis to help you understand the data.

A **Analyze** the system to identify ways to eliminate the gap between the current performance of the system or process and the desired goal. Use statistical tools to guide the analysis.

I **Improve** the system. Be creative in finding new ways to do things better, cheaper, or faster. Use project management and other planning and management tools to implement the new approach. Use statistical methods to validate the improvement.

C **Control** the new system. Institutionalize the improved system by modifying compensation and incentive systems, policies, procedures, MRP, budgets, operating instructions and other management systems. You may wish to utilize standardization such as ISO 9000 to assure that documentation is correct. Use statistical tools to monitor stability of the new systems.

FIGURE 12.1
Overview of how DMAIC works.

is often used to create a *gated process* for project control. Criteria for completing a particular phase are defined and projects reviewed to determine if all of the criteria have been met. If so, then the gate (e.g., Define) is *closed*.

DMADV Process Clarified for LMS

The basic DMADV method consists of the following five steps:

1. *Define:* Define design goals that are consistent with customer demands.
2. *Measure:* Identify and measure product characteristics that are critical to quality (CTQ).
3. *Analyze:* Analyze to develop design alternatives, create a high-level design, and evaluate design capability to select the best design.
4. *Design:* Complete design details, optimize the design, and plan for design verification.
5. *Verify:* Verify the design, set up pilot runs, implement the production process, and hand it over to the process owners.

DMADV is also known as DFSS, an abbreviation of *Design for Six Sigma*.[1]

Overview of How DMADV Works in LMS

One strategic objective of any organization is the continual improvement of its business systems and processes to gain competitive advantage, enhance its performance, and benefit interested parties such as customers, employees, and shareholders. In many situations, however, improving a business system and/or process is not a sound business option. Rather, a complete system, process design, or redesign is required. DMADV is the Lean Six Sigma design team methodology that focuses on process design/redesign. In Define, the LMS purpose and scope is established by

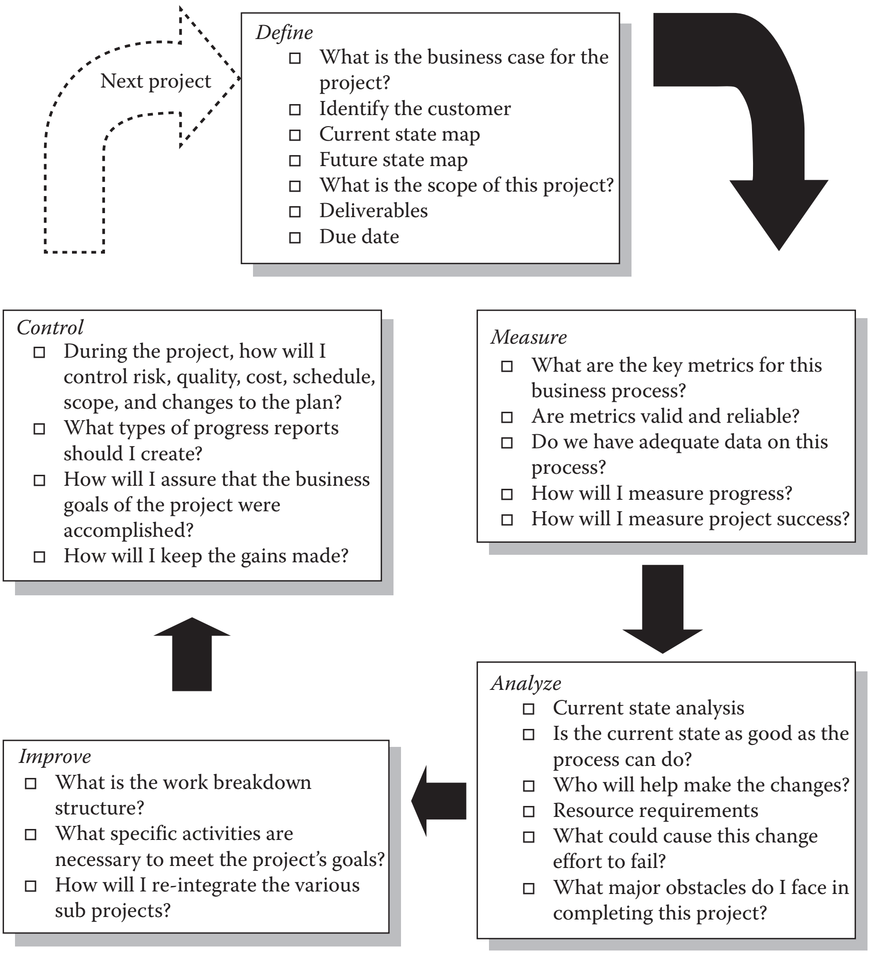


FIGURE 12.2
Pyzdek model of DMAIC on a Six Sigma project. (Used with permission where proper attribution is given. See www.pyzdek.comdamicdmadv_files for more details.)

the design team. In Measure, LMS voice-of-the-customer (VOC) data are translated into CTQ characteristics (i.e., design measurements) that the LMS design must meet.

The LMS design team then generates innovative Design concepts, evaluate and select the best concept for the LMS design (Analyze). High-level designs are then developed and tested (Design). Verification against design requirements and validation against intended use are followed by transitioning the new design to process owners for rollout, implementation, and control, completing the DMADV methodology.

Another approach, used when the goal is the development of a new or radically redesigned product, process, or service, is DMADV. DMADV is the part of the DFSS toolkit (see Figure 12.3).

Comparing DMAIC and DMADV-LMS*

DMAIC is a process improvement tool that is used to modify a process that already exists and is not providing the performance that is desired. It provides a foundation for a systematic and structured examination of any process.

Conversely, DMADV-LMS is a process definition and creation tool all in one. It outlines a systematic approach to define, create, and execute a new process where no process currently exists. Although DMAIC and DMADV have some similar characteristics, DMADV-LMS holds the advantage of bringing a systems approach and a completely clean slate. Also, it promotes creative and innovative thinking to create the best LMS design possible from the customer's standpoint. It allows LMS and process designers the freedom to brainstorm with the approach…. "If I had a magic wand and could create the perfect process…what would it look like." DMADV-LMS is a powerful tool for new process creation. Figure 12.4 illustrates the relationship between DMAIC and DMADV.

Voehl's Law: Use DMAIC to Improve Processes, DMADV to Design New Ones, and LMS-DMADV to Manage in a Lean Management System Environment

* Brief overview by Thomas Pyzdek, and expanded by Frank Voehl and Rich Charron for the LMS model. Reproduction allowed if no changes are made to the content and a link to the original work at http://www.pyzdek.com/ from our monograph. The DMAIC road map was provided by OPEX Resources, as mentioned in footnotes ‡ and ||.

	LMS Phase	LMS Goal	LMS Toolkit
D	**Learning to See**	**Define** the goals of the design activity. What is being designed? Why? Use QFD or Analytic Hierarchical Process to assure that the goals are consistent with customer demands and enterprise strategy.	• Define Customer Requirements • Identify Lean Measures • Lean Kaizen Plan • Lean Value Stream Map (VSM)
M	**Learning to Measure**	**Measure.** Determine Critical to Stakeholder metrics. Translate customer requirements into project goals.	• Lean Benchmarking or Scorecard • Current State Charts (Hand-off, Spaghetti, Process Maps, Process Flows) • Lean Measurement Systems Analysis • Lean Qualitative Measures Assessment (Quality @ Source, POUS, Continuous Flow, 9 Waste Checklists) • Lean Quantitative Analysis–Pareto Analysis (Process Defects)
A	**Learning to Learn & Analyze**	**Analyze** the options available for meeting the goals. Determine the performance of similar best-in-class designs.	• 5 Why's • Current State Charts Analysis • Lean Qualitative Measures RCA Analysis • Lean Quantitative Measures RCA Analysis
D	**Learning to Improve**	**Design** the new product, service or process. Use predictive models, simulation, prototypes, pilot runs, etc. to validate the design concept's effectiveness in meeting goals.	• 5S and 7M tools • Apply 13 Lean Tools–5S, Quality @ Source, POUS, Standardized Work, Cells, TPM, Facility Layout, SMED, Batch Reduction, Kanban, Visual Controls, VSM, & Kaizen • Create & Deploy Future State Charts (Hand-off, Spaghetti, Process Maps, Process Flows) • Create Future State Qualitative Measures • Create Future State Quantitative Measures • Complete Try Storm Pilot Improvement Projects

FIGURE 12.3
Overview of how DMADV-LMS works.

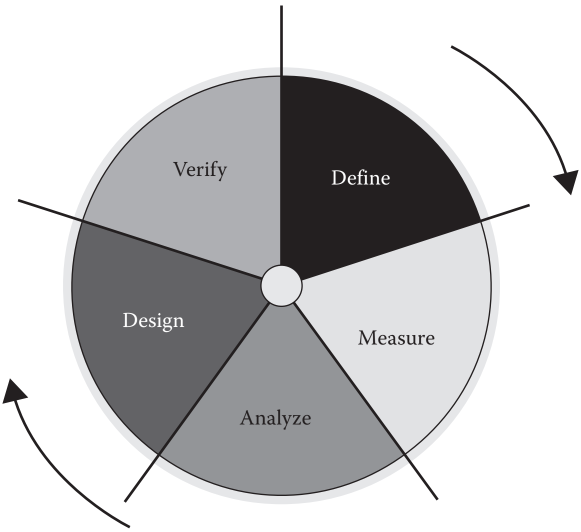


FIGURE 12.4
LMS design road map using DMADV.*

* The DMADV road map model presented here is a rough adaptation of the Quentin Brooks DMAIC road map. The Brooks DMAIC model was originally developed for inclusion in the Six Sigma using MiniTab book, version2, by the Quality Management System Consulting Group in the United Kingdom. The authors have used this road map to create the DMADV and the LMS road maps presented in this book and the DMADV road map for the *Black Belt Handbook* (Productivity Press, 2013, pp. 485–487). The following review is taken from the *Quality World* magazine, published by the Chartered Quality Institute, London (www.thecqi.org). "Book of the Month: *Lean Six Sigma and Minitab*," *Quality World* magazine, Volume 37, Issue 2, February 2011. "There are literally thousands of Lean Six Sigma books, guides and roadmaps available to the avid quality reader, with The Complete Toolbox among the best-selling. The book comes with strong endorsement from BT, among others. The third edition is split into seven sections, the first five following the DMAIC principles of define-measure-analyse-improve-control, with an additional 'manage' section and appendices. Written in clear, simple English, the book uses easy-to-follow process flows that work not only within their specific section of the book, but also with other sections and linked concepts, tools, and techniques (125 of them in total). The guide doesn't offer a 'follow-me' type approach, rather it states what should be happening at every stage and gives options for successful project delivery.… the book tends to prompt rather than tell, and asks the reader key questions such as what's wrong and what do you want to achieve, to elicit meaningful responses. Another great feature of the book is the wealth of content available online from OPEX Resources, which gives the reader valuable tools. While the book probably isn't suitable for someone starting out with Lean Six Sigma, it is pretty much a one-stop-shop for all the tools a practitioner might need. In all, it's a solid companion for any Lean Six Sigma practitioner." (Note: This review was written for the CQI by Chris Morgan, MCQI CQP). They can be contacted at info@opexresources.com (T: +44 (0)845 388 5835); F: +44 (0)8717 335 413. OPEX Resources Limited, 25 Clifton Road, Winchester, Hampshire SO22 5BU, United Kingdom.

No matter how you approach deploying improvement teams in your organization, they will all need to know what is expected of them. That is where having a standard improvement model such as DMAIC is extremely helpful. It provides teams with a road map. DMAIC is a structured, disciplined, rigorous approach to process improvement consisting of the five phases mentioned, where each phase is linked logically to the previous phase as well as to the next phase.

INTEGRATING LEAN WITH DMAIC/DMADV

The worlds of Lean and DMAIC/DMADV (Six Sigma) have been seemingly at odds for many years. This is primarily due to the difficulty of practitioners grappling with the two fundamentally different concepts: identifying and eliminating waste versus identifying and eliminating variation. As different approaches to process improvement, when applied in the proper situation, Lean and DMAIC/DMADV can integrate to form a more powerful tool than either can be standing alone.

Virtually all Lean concepts integrate well with the DMAIC and DMADV. Our purpose in this section of the handbook is to focus on special considerations for using the Lean concepts integrated with the DMAIC/DMADV process in any environment, including both methods and tools that are particularly helpful, as well as hints on how to model the people side of each phase.

Lean thinking supports two basic disciplines for speeding up the knowledge creation process: short, frequent learning cycles and delayed commitment.

Short, frequent learning cycles are the antithesis of thorough front-end planning, but they are the best approach to processes that have the word *development* in their title. In product development, for example, the typical process is to define requirements, choose a solution, refine the solution, and implement the solution. Although this process is common, it is not the best way to generate knowledge. Conversely, the delayed commitment approach of Toyota is much faster and delivers products of superior quality that consistently outsell the competition. Toyota builds sets of possibilities to satisfy customer needs and then, through a series of combining and narrowing, the new product emerges. The combining and narrowing process is paced by milestones that define stages of the narrowing process.

Milestones are always met, despite the fact that there are no task breakouts or tracking. Decisions are delayed as long as possible so that they can be based on the maximum amount of information.

Project managers can have the same *already full of tools* problem. Depending on where they work, they probably see the Project Management Body of Knowledge (United States-based) or PRINCE2 (Europe-based) as a compelling road map and toolkit that engages a lot of their attention. Although there are places where Six Sigma as *road map and tools* can add significant value within software professionals' existing scope of work, it can be pretty hard to see from inside looking out. Struggling to find a fit from this perspective also is unfortunate in another way. It has a big blind spot for the most powerful aspect of Six Sigma—its ability to connect business leaders and key project teams in a potent two-way, fact-based dialogue. To see and understand that, an exploration of Six Sigma tollgate-level architecture is needed.

Lean management tools can be dovetailed to fit with virtually any DMAIC or DMADV project. They can be used to accent DMAIC or DMADV concepts and tools or as stand-alone techniques to produce a vital component of the DMAIC/DMADV project. Table 12.1 illustrates how and where Lean tools can be integrated with DMAIC/DMADV.

Lean DMADV-LMS Framework

As illustrated in Table 12.1, the application of Lean tools and techniques fit well into the structured approach of Six Sigma. Whether you are conducting a DMADV project or building an LMS, Lean can play a significant role in either process design or process improvement. Both concepts fit well in the tollgate road map format, align with a structured approach, and have at their core the use of RCA as a means for driving effective and permanent process improvement.

Need for Tollgate Road Maps

Tollgate road maps are simply a means of engaging the system designers, stakeholders, and customers to envision and justify the effort, along with the verification that requirements are met. As a means to achieving consistent processes and staying on track, they are a Go/No-Go gauge for process quality. As with turnpikes and toll roads, the *toll* is dependent on the load, and you must pay to use the resources. Tollgates prevent resources

TABLE 12.1

Lean Tools for DMAIC and DMADV

LMS Phase	Lean Tools
Define	• Define customer requirements • Identify Lean measures • Lean Kaizen Plan • Lean value stream map (VSM)
Learning to measure	• Lean benchmarking or scorecard • Current state charts (hand-off, spaghetti, process maps, process flows) • Lean MSA • Lean qualitative measures assessment (Quality @ Source, point of use storage (POUS), continuous flow, nine-waste checklists) • Lean quantitative analysis–Pareto analysis (process defects)
Learning to see	• 5 Why's • Current state charts analysis • Lean qualitative measures root cause analysis (RCA) • Lean quantitative measures RCA
Learning to improve (Design)	• 5S and 7M tools • Apply 13 Lean tools—5S, Quality @ Source, POUS, standardized work, cells, total productive maintenance, facility layout, single-minute exchange of die, batch reduction, Kanban, visual controls, VSM, and Kaizen • Create and deploy future state charts (hand-off, spaghetti, process maps, process flows) • Create future state qualitative measures • Create future state quantitative measures • Complete try storm pilot improvement projects
Learning to control (Verify)	• Lean sustainability–Kaizen action plans • Visual measures deployment • Lean educational plan deployment • Lean communications plan • Lean visual control charts • Lean visual management reporting

from being wasted. They help facilitate the VOC and the stakeholders. They also ensure conformance to standards and help us to validate solution against requirements.

Like any other organization enhancement process, there are steps that must be followed. Lean Six Sigma is no exception. In fact, the process has what we call tollgates, and there are 12 of them. Figure 12.4 incorporates numerous elements that assist the Lean management teams to scope out the right business case, build realistic goals and measurements, analyze the right issue(s), and create proactive solutions and finally institute controls

and tracking mechanisms that reinforce best practices. It is our road map for achieving higher performance.

DMADV-LMS Tollgate Road Map

DMAIC is an acronym for Define, Measure, Analyze, Improve, and Control. It is a structured, disciplined, rigorous approach to problem solving and process improvement where each phase is linked logically to the previous phase and to the next phase. In addition, each phase has specific assessment tools that you will be introduced to as we progress on this journey to becoming practitioners in the best practices of process improvement. Following the OPEX methodology will help the organizations achieve the subsequent Lean goals: We focus first on the tollgates as a structure for a project, with each of the tollgates seen as a set of leadership questions that need to be thoroughly addressed at key milestones, and the Lean and Six Sigma road maps and tools can be seen as means to answering these questions. From this point of view, Six Sigma can be seen as enabling a high-level, closed-loop control on growing business value and reducing risk.

Root Cause Analysis and Lean Management

The common crossover point between Lean and DMAIC/DMDV is in RCA. The primary difference between Lean and DMIC/DMADV is that Lean projects can use both qualitative and quantitative RCA analyses. The quantitative tools are identical to DMAIC/DMADV, such as 5 Why's, cause and effect diagrams, failure mode and effects analysis, to name a few. However, within the analysis tollgate, there are a number of questions about current practice or activities that address the Lean qualitative aspects of the process. These questions guide the RCA thought process and could include the following:

- Is continuous flow present?
- Are employees using standardized work procedures or visual work instructions?
- Does the process use *Quality @ the Source* concepts for each process step?
- Is POUS in place or just-in-time materials motion?
- Are cellular concepts being used?

- Is the *facility layout* effective with properly sequenced process steps connected?
- Are there large distances traveled by equipment, materials, or employees? Are large quantities of materials moved?
- Are employees practicing Kaizen daily?

RCA is a structured process that uses a collection of tools and approaches to uncover causes to problems. The idea is to become more acquainted with the Lean RCA toolbox and apply the appropriate tools and technique to address a serious non-Lean workplace situation. Further, because problem solving is an integral part of the Lean management continuous improvement process, RCA is viewed as one of the core building blocks of the Lean organization.

In itself, RCA will not produce any results as it must be made part of the larger problem-solving effort, part of the conscious attitude that embraces a relentless pursuit of improvements at every level in every department or business process of the organization. In short, RCA is a highly versatile analysis approach, which needs some structure to be successful. The sheer number of groups of tools available can be enough to dissuade anyone from embarking on analysis.

Groups of Lean Management System-Related Root Cause Analysis Tools

This is a short summary of RCA tools that are presented in Chapter 4 of our *Six Sigma Green Belt Handbook*.* RCA tools can be grouped into five categories, which are closely aligned to the DMAIC (and not DMADV) problem-solving process. They somewhat naturally fall into five categories:

1. *Problem definition and understanding:* Methods that help get to the bottom of the problem and its nature
2. *Problem cause generation, measurement and data collection:* Tools that can be applied at different stages in the analysis
3. *Problem and possible cause analysis:* Tools used for making the most of the data being collected about the problem

* See *The Six Sigma Green Belt Handbook* by Harrington, Gupta, and Voehl for more details (Paton Press, 2009).

- *Improvement-oriented activities:* Tools used for smoothing the implementation part of the journey
- *Control-oriented activities:* SPC tools for locking in the gains and keeping things under control
- *Software-related activities:* Use of MiniTab software tools to design and create (and maintain) an LMS.*

SUMMARY

LMS and DMAIC/DMADV can be integrated to achieve excellent process improvement results, as the DMADV-LMS model clearly illustrates. The qualitative and quantitative approaches used in the LMS philosophy include waste identification and elimination, which can be seamlessly woven together by using deployment strategies involving both DMAIC and DMADV projects. This chapter presents a systematic approach to achieve this integration.

Using LMS thinking tools in the Define and Measure phases of projects allows for the capture of qualitative Lean concepts that may be missed in a pure DMAIC project. Often these qualitative concepts can be quantified as the projects proceed to Analyze, Improve, and Control phases of the DMAIC or the Analyze, Design, and Validate phases of the DMADV. The reader can now begin to get creative with the integration of these two powerful process improvement techniques and adapt them to individual organizational needs.

REFERENCE

1. Joseph A. De Feo and William W. Barnard. *JURAN Institute's Six Sigma Breakthrough and Beyond: Quality Performance Breakthrough Methods*, Tata McGraw-Hill Publishing Company Limited, Noida, India, 2005.

* As mentioned earlier, OPEX Resources previously developed a book for DMAIC use with MiniTab, and we are envisioning a similar monograph effort and collaboration with Quentin Brook, Brett Trusko, and Chuck Mignosa called LMS using MiniTab. It is our intent that this work be copublished with Kogan Page in the United Kingdom to capture a share of the European marketplace for Lean Six Sigma.

13

Integrating Lean and Theory of Constraints

Alex Fedotowsky

IN A NUTSHELL

Similar to Lean and Six Sigma, theory of constraints (TOC) is both a philosophy and a process improvement tool. As discussed in several chapters of this handbook, in general terms, Lean means *identifying and eliminating waste*, whereas Six Sigma means *identifying and elimination variation*. In this chapter, we present and discuss the TOC, which means *identifying and eliminating constraints* or *identifying the constraint and restructuring processes around the constraint to mitigate its negative effects on the organization*. The basic premise of TOC is to identify the few high-level constraints in any process in your organization. Once identified, continue to raise the importance and visibility of this constraint and apply resources as necessary to remove, mitigate, or circumvent the constraint. This process is repeated as you move across your organization applying resources to remove the deleterious effects of these few major constraints that are restricting the organization from achieving higher and higher levels of productivity and profitability. The TOC matches up well with Lean as the two approaches do come to improvement from different directions and can complement each other as Lean can be used as an improvement tool on TOC projects.

OVERVIEW

TOC provides the framework to apply Lean and Six Sigma efficiently by identifying the constraint in process and then applying Lean Six Sigma

methods to eliminate the constraint. Instead of a shotgun approach, you pinpoint where to apply the Lean Six Sigma resources, because not all process steps are equal in their return on investment. According to the terminology of Eliyahu Goldratt, this is called elevating the constraint so it does not remain the constraint. Once you eliminate the constraint, another constraint takes its place. The cycle continues to improve the system.

Definition of Constraint

1. *n*; limitation or restriction.*
2. Goldratt describes *constraints* using several approaches; a common description is *anything that limits a system from achieving higher performance verses its goal.*

Goldratt created five steps to mitigate or eliminate the constraint:

1. *Identify the constraint:* identify a physical process step, an outside source, or a corporate policy that restricts throughput.
2. *Exploit the constraint:* decide how to do everything possible to use the constraint to its maximum capability. Apply Lean, Six Sigma, or any other process improvement methods where applicable.
3. *Subordinate to the above decision:* all other activities should be adjusted to support and defer to the constraint, to insure it operates at peak effectiveness. Through champion sponsorship, assure the Lean or Six Sigma project attacking the constraints has dedicated resources.
4. *Elevate the constraint:* if system performance is still not satisfactory, consider investments to improve or eliminate the constraint. In some cases, expenditure for new technology or job skills may be required to eliminate the constraint.
5. *Repeat the cycle:* when the current constraint is broken or removed, go back to step 1 and identify the next constraint in the system. Examine the culture, policies, and prepare the organization to become a Lean management organization. As the organization eliminates the next constraint, the throughput will continue to increase. Successful competitive throughput is how an organization improves profitability.

* *Webster's New Universal Unabridged Dictionary.*

Goldratt states that the purpose of a commercial organization is to make a profit. This is achieved by increasing throughput, reducing inventory, and reducing operating expenses to meet demand at a lower cost. According to Goldratt, profit equals throughput minus operating expenses, whereas inventory is embedded as an operating expense. Only throughput the required quantity based on sales, otherwise you build inventory and over-produce, increasing the operating expense. In addition to Lean and Six Sigma, the TOC body of knowledge has produced a powerful method to focus resources to eliminate or dramatically reduce system constraints.

TOC describes a drum–buffer–rope (DBR) model as a tool for improvement. DBR refers to a description of portions of TOC in application. The *drum* refers to the restriction or most limiting resource in the process. Buffer refers to an amount of *time* between orders entering the system to cover or protect from the loss of capacity at the drum. *Rope* is another time element that is used to tie drum to product or service delivery for the customer.

Applying DBR assumes there are steps within a process designed to deliver a product or service that will not have the resources or capacity to maximize output. Such steps in a process are constraints. The organization's resources are either spread too thin or nonexistent. The pace or capacity of the constraint is the drum beat. If the drum step is overfed with resources, you build inventory; if it is underfed, you starve the system further reducing the throughput. Therefore, the drum step requires a time or material buffer to maximize the flow within the constraint. To assure the proper amount of materials, resources flow into the drum; a rope is created to release these resources. The rope can take form as a production order, a Lean signal such as a kanban or visual control, or a labor request to manage the buffer connected to the drum.

COMPARING LEAN AND THEORY OF CONSTRAINTS

To compare Lean and TOC, we need to expound a little on what TOC is. Similar to Lean and Six Sigma, TOC is an operational philosophy in nature. It looks at organizations and processes through the eye of constraints. What constraints do we have in the system? How are they affecting my performance? What are the best courses of action to eliminate or circumvent these constraints?

TOC is an approach to managing complex systems, that is, organizations comprised people working in interdependent, interacting processes.

The objective of TOC is to grow a system's capability to achieve more of its goal, now and in the future. It consists of a *theory* of dealing with systems by identifying and managing constraints, which are often based not in the technical limitations of a process (that the tools of Six Sigma are so good in dealing with), but in the paradigms, practices, and policies of the people who are involved with them. Hence, key components of the TOC *body of knowledge* are in the logical thinking and communication tools known as the TOC thinking processes.

These thinking processes, when used by people with intuition about the system in question, go a long way to providing what Deming refers to as *profound knowledge*, and providing a way for managers to be able to better predict the outcomes of their actions, as the following table illustrates:

Lean and Six Sigma Approaches (Waste and Variation Identification and Elimination)	**TOC Approach (Constraint Identification and Elimination)**
Lean and Six Sigma work primarily at the level of a local link of a system's chain, and its interaction with its immediate supplier and customer processes.	TOC drives focus to the perceived weakest link in a process and then to the linkages between that constraint and other aspects of the system.
Six Sigma, which relies on a data-driven philosophy, is great for solving technical issues that are subject to quantitative analysis.	TOC, with its logic-based tools, provides strength in dealing with what might be considered *qualitative* analysis, helpful for dealing with *rock and hard place* dilemmas.
Lean Six Sigma approaches root cause with traditional *quality tools* like fishbone (Ishikawa) diagrams and failure mode and effects analysis, with searches for many possible root causes of a single problem.	TOC's approach to root cause analysis, centered in the thinking process known as the current reality tree, starts with a range of diverse problems with which the system suffers and then builds rigorous cause-and-effect logic to identify one constraint.
Lean and Six Sigma, with its quality roots, focus on either minimizing waste or minimizing variation associated with the flow of product or service.	TOC first strives to build *logistical* processes that are robust enough to deal with current variation, and through concepts like the five focusing steps and *buffer management* (i.e., using buffers to cover for process weaknesses).
The Lean Six Sigma approach to value for the customer is closely tied to assuring that products and services delivered meet or exceed specifications or requirements of those outputs.	TOC extends its use of the constraint to define maximum value for a market segment or customer in terms of the constraint or core problem of their system.

ACHIEVING LEAN EFFECTIVENESS WITH THEORY OF CONSTRAINTS

Although Lean and TOC describe two different approaches to process improvement, they are highly complementary. TOC, or constraint management, provides an environment in which the players can understand their system profoundly. It strives, with its logistical solutions like DBR operations management (all employee activities conducted within the operation to meet customer demand), critical chain project management (CCPM) (activities to assure uninterrupted continuous order flow), and replenishment distribution (activities to assure materials at the ready for future demand), to stabilize those systems to a degree that the places that Six Sigma efforts should be applied is obvious and focused, and that the outcome of those problem-solving efforts can be predicted and capitalized upon.

TIPS FOR LEAN–THEORY OF CONSTRAINTS PROJECTS

Proper project definition and scope are always the key drivers of both Lean and Six Sigma project success. Similarly, Lean–TOC projects should be scoped to take advantage of the constraint focus. A number of tips regarding application of the five-step TOC process should help you see the relationship between Lean and TOC in the project context.

Lean can be an effective part of a TOC project. Lean methods are introduced into the processes to deliver value the customer is willing to pay for because Lean eliminates most waste in a process and reduces lead times, increases capacity, and delivers a product or service at a reduced cost. For example, a current state value stream mapping (VSM) can be used to identify possible constraints (step 1: identify constraint) and be very valuable when defining a strategy (step 2: exploitation) to attack the constraint. The VSM is an excellent diagnostic tool that can be used in constraint management. The VSM brings visibility to a process that produces the product or service while illustrating the ratio of value-added versus nonvalue-added activities that transform the product or service.

Similarly, Six Sigma can also be a complimentary component of TOC projects. An effective use of Six Sigma is primarily to get more throughput

through the constraint (step 2: exploitation). In this case, one can use Lean projects to drive waste out of the constraint and Six Sigma projects to drive variation out of the constraint. If the constraint is in a manufacturing process, projects associated with scrap reduction and uptime improvement should be applied to its operation. If the constraint is in the market, that is, if you have more capacity than demand, then internal Lean or Six Sigma projects should be aimed at doing things that will make the system's offerings more attractive to potential customers—typically associated with customer response time and reliability of offered promises.

Secondarily, Six Sigma tools and techniques can be used to drive down disruptive variation in nonconstraint system processes that either interfere with or waste the output of the constraint (step 3: subordination). Again using a manufacturing example, once product has passed through an internal constraint process, function, or resource, you want to treat it like gold. After all, to replace it will require another trip through the precious constraint. Projects on downstream processes should therefore focus on serious issues of quality of output and scrap reduction. Projects on upstream processes are primarily aimed at reliability so that the constraint is never starved for work or presented with poor quality inputs.

With these kinds of projects as the focus of Six Sigma efforts, maximum bottom-line impact should result. Make sure, however, that when the constraint moves as a result of your efforts, the focus moves with it. Just when you are getting good at getting more through the system in terms of quantity, you may need to shift to thinking about speed instead of volume to attract more market. Do not waste the precious time and attention of your Lean practitioners, or yellow, green, and black belts (and your management) on projects that are only strengthening already stronger links of your chain. Instead, use TOC to focus their efforts on the weakest links. That is the primary location to enact systemic changes and achieve bottom-line improvements.

If a process experiences high variation either through customer demand or internal production capacity stages, balancing the workload or other Lean Six Sigma methods may not be enough to create an efficient work flow or what Goldratt, founder of TOC, refers to maximizing throughput. In this case, Goldratt redefines throughput as sales orders that need to be pulled through the production system. If you have no sales orders, you have no need to produce unless you want to build up inventory. The goal of any profit organization is to increase profit by increasing throughput.

THEORY OF CONSTRAINTS CRITICAL CHAIN PROJECT MANAGEMENT AND LITTLE'S LAW

An organization that depends on successful project completion to make profit would desire to complete projects ahead of schedule without increasing resources. To increase profits, the organization typically will start as many projects as possible into the work area overwhelming current resources. New constraints emerge because the same number of people with less resources or more people with limited resources such as tools, materials are forced to support more projects resulting in job multitasking. Multitasking simply extends deadlines resulting in delays that effect a system's performance, customer satisfaction, and being paid for the project.

This type of ineffective project management and delayed project completion can result in a variety of symptoms. Common symptoms are described as Murphy's law, Parkinson's law, and the student syndrome. All can play major roles in extending project completion:

- Murphy's law simply states that what can go wrong will most likely go wrong.
- Parkinson's law states that a project or task will take the entire time allocated by the management.
- Student syndrome states that people have a tendency to complete their project just before the due date.

Complex projects with multifaceted interfaces with suppliers and customers can further delay a project completion to the dissatisfaction of all stakeholders. Two methods have evolved from the TOC to correct the adverse effects: Little's law and CCPM.

1. *Little's law:* This law simply states that the amount of work in process (WIP) must be equal to the cycle time it takes to complete a project or product times the number of projects/products completed in a time frame (throughput). To benefit from Little's law, you make every effort to reduce your WIP by decreasing the cycle time and either maintain the current throughput or increase it. With less WIP, you reduce resource constraints allowing for faster completion times.

2. *CCPM:* CCPM, refined by Goldratt, is a method of planning under TOC to decrease completion time or cycle time in a resource contention project environment. CCPM is the antidote for Parkinson's law and the student syndrome. Instead of creating time durations for task completion with added buffer time typical in a Gantt chart, a project buffer is created at the end of the project by taking all the tasks associated with the project, cut the calculated completion time by 50%, and add a large project buffer at the end. If there are subprojects that feed into the main project, then there need to be feeder buffers into the main project chain of tasks. Now that you cut the completion time by 50%, you manage the buffer, which becomes your constraint, by applying resources. If the buffer time is 10 days and you used only 4 days in managing the buffer to complete the project, you saved 6 days, reduced cycle time, allowing the system to increase throughput.

INTEGRATING LEAN AND SIX SIGMA UNDER THEORY OF CONSTRAINTS EXAMPLE

Army Fleet Support at Fort Rucker, Alabama, has made dramatic improvements in reducing aircraft scheduled maintenance cycle time and increasing throughput with the support of a CCPM software called Concerto (Realization Inc., San Jose, CA). The maintenance process is broken down into very detailed tasks that are input into the Concerto database. Applying CCPM algorithms, Concerto directs the teams what actions are required to complete tasks and manage the buffer. It calculates tasks' completion by percentage against used buffer time creating a color-coded chart to alert the teams when too much buffer time is used and where the constraints are in real time.

Buffer time absorption is where the constraint is and the teams with management support take action in the form of Lean, Six Sigma, or managing resources. Thus cycle time is reduced, lowering WIP while increasing throughput. As a result, at one airfield, while reducing WIP from eight to six aircraft in the hanger, maintenance cycle time was reduced from 45 to 25 days, a 44% decrease. This allowed an extra two aircraft to be available each month. Because the Army did not have to purchase an extra two aircraft to meet its training needs, the estimated

annual cost savings and cost avoidance calculated to be approximately $53 million.

In addition to financial gains, employee morale improved because the best ideas to elevate the constraint came from the frontline workers performing the task. This example shows how Lean and Six Sigma are applied to the constraint identified under TOC or CCPM framework with or without the aid of a software package such as Concerto.

SUMMARY

Integrating Lean and TOC can achieve powerful process improvement results. Identifying the few critical constraints in your organization and mitigating these with a focused Lean TOC may produce a much higher impact in generating profits than either method alone. Recognizing that Lean and Six Sigma can also play a role in identifying a constraint, the Lean value stream map tool and the statistical analysis of variance method can be used to identify major organizational constraints. As organizations mature with the knowledge and resources provided by Lean and Six Sigma, TOC can also play a role in the Lean management system.

TOC, Lean, and Six Sigma provides practitioners with a basic understanding of the systematic approach to integrating the three methodologies—regardless of the organizational or operational environment—to ensure system improvement occurs through focusing improvement on the right interdependencies. Understanding the key differences and overcoming the discords allows an organization to use this new approach to take full advantage of the best practices available today.

Decisions should promote a growth strategy. While enterprises should attempt to simultaneously increase throughput, decrease inventory, and decrease operating expenses, the focus should be on improving the throughput of the entire value chain/supply chain.

Focus on bottleneck resources because they control the flow. Synchronize flow by first scheduling the bottleneck resources on the most productive products; then schedule non-bottleneck resources to support the bottleneck resources.

Do not just focus on balancing capacities.

Focus on synchronizing the flow.

REFERENCES

1. Abraham Goldratt Institute, The Theory of Constraints and its thinking processes; a brief introduction to ToC (online). Available at http://www.goldratt.com/pdfs/toctpwp.pdf, 2009, (accessed August 8, 2013).
2. W.H. Dettmer, Beyond Lean Manufacturing: Combining Lean and Theory of Constraints for high performance (online), Goal System International. Available at http://goalsys.com/books/documents/ToCandLeanPaper-rev.1pdf, 2001, (accessed August 8, 2013).

14

Lean Management System: Organizational Master Plan

IN A NUTSHELL

In this chapter, we present the six phases of developing a Lean management system organizational master plan. Each of these phases contains a detailed list of activities that can be used during the development of a Lean management system. Each company's organizational master plan will be different. Consequently, each of the phases identified in this chapter and subsequent phase activities should be defined and redefined depending on your company-specific needs. Our objective here is to give you a fairly comprehensive framework as a starting point to edit into your custom Lean management system organizational master plan.

In Phase I, you evaluate the methodology. This means, beginning to generate interest in the development and deployment of a Lean management system. It also means searching for knowledge on what a Lean management system is and how your employees are currently positioned to define and deploy a Lean management system. During this phase, you take a look at possible places within your organization where Lean may be applied. Regardless of how many activities you define in Phase I, the primary objective is to build a strong case and gain the support from senior management that is required to make a Lean management system a success.

In Phase II, you will begin to define the opportunities within your organization. The first step is to define the controllable factors and develop *as-is* current state statements of each key controllable factor. For each key controllable factor, you need to define and quantify the opportunity for improvement. At this point, you will want to compare the types of projects you are considering with existing projects to be sure that there is no overlapping works. On gaining approval to proceed from top management,

the next activity is to assign a project manager and create project teams. At this point, you need to consider a budget for the next phase, which is implementation planning.

In Phase III, you develop an implementation plan. During this phase, there are several activities. These include developing individual vision statements for each key controllable factor, defining the desired employee behaviors, preparing individual improvement plans, preparing cost–benefit analysis, setting performance goals, and presenting an overall Lean management system project plan to the top management. Depending on your organization, the number of activities in this phase can vary.

In Phase IV, you implement the Lean management system plan. This includes assigning project managers and employees to participate on implementation teams. Also important in this phase is to develop trust with your employee base that any employees displaced as a result of process improvements will be reassigned to other value-added areas of the organization. During the implementation, teams go about measuring and defining the current states of operation. They conduct training for some of the project teams where required. They look into possible organizational change management assessments.

In Phase V, we define and deploy an effective measurement system. This includes understanding what measures drive the key controllable factors. Defining how we will collect data required to monitor these key controllable factors. Things like what data are required, who will collect the data, from where we collect the data, how we analyze the data to know whether or not we are improving the process, and finally, how we will visually present and report the data. After demonstrating here via a comprehensive measurement system that we have truly improved the processes, we need to prepare rewards and recognitions for the hard work completed by the process improvement teams.

In Phase VI, after standardizing the process, we turn our focus to continuous improvement activities. These include sustaining the gains that we have achieved on all the projects that we committed to and completed. This also means developing an ongoing improvement strategy in essence making sure that our improvement activities are part of our daily routines.

Regardless of what industry you are in, what type of company you run, or the size of the organization; you will need some form of Lean management system organizational master plan. It is up to you to define the scope and nature of your organizational master plan using the framework provided in this chapter.

OVERVIEW

To this point, we have presented a lot of information and concepts related to what is required to have a Lean management system in place and working. If you have read up to this point in the book, you might be probably thinking, "What does it take to put in place a Lean Management System and get it working?" Well, that is a good question and one that cannot be addressed casually. Unfortunately, there is no one best Lean management system—there are only a few basic concepts that should be followed. Each organization has to fine-tune the implementation/transformation processes to the unique needs of the people in the organization, its unique outputs, and its specific customers. We are going to present a six-phase approach for making the transition to a Lean management system.

- Phase I: Evaluate the methodology
- Phase II: Define opportunities within the organization
- Phase III: Develop the implementation plan
- Phase IV: Implement the plan
- Phase V: Measure the results
- Phase VI: Continue to improvement

This approach will expose a dozen things that can cause a Lean management system to fail:

1. Lack of management support
2. Doing too many things at the same time
3. Lack of a good project leader (champion)
4. Too costly to implement
5. Lack of cultural or social change acceptance
6. Poorly defined objectives
7. Poor results management system
8. No budget to support the project
9. Lack of proper education and training
10. Poor project and/or change management environment
11. Not implemented at the management level
12. Results in dismissal of people

The six-phase approach that follows is designed to help your organization to avoid these 12 common traps or failure points. More importantly, this approach will allow you to describe in detail those activities that are required to define and deploy a comprehensive Lean management system. This effort requires a systematic and disciplined approach to achieve a successful Lean management system.

PHASE I: EVALUATE THE LEAN MANAGEMENT SYSTEM METHODOLOGY

During this phase, someone is assigned or someone takes it on himself/herself to study the Lean management system methodology and tools to define its applicability to the organization's situation, structure, and culture. Based on this evaluation, top management will define if a study team will be assigned to do a detailed analysis of what impact a Lean management system could have on the organization.

This phase consists of six activities:

- *Activity 1:* Starting the interest in Lean management systems
- *Activity 2:* Search for knowledge on Lean management
- *Activity 3:* Complete the Lean management system assessment (LMA)
  - *Activity 3.1:* Identify gaps between current organizational activities and LMA criteria
  - *Activity 3.2:* Evaluate current socio-technical system
  - *Activity 3.3:* Evaluate current Lean educational system
  - *Activity 3.4:* Evaluate current Lean change management system
- *Activity 4:* Analyze application of a Lean management system (conceptual evaluation)
- *Activity 5:* Prepare management report (deploying a Lean management system)
- *Activity 6:* Present findings to top management

Activity 1: Starting the Interest in Lean Management Systems

Generating interest and consensus that the organization would benefit from the adoption of a comprehensive Lean management system may

require some effort. The way an individual organization becomes interested varies based on the situation. Typical ways are as follows:

- Someone reads an article in a magazine, which stimulates the interest to start evaluating the application of Lean management system to the organization.
- An acquaintance of someone in the organization tells them about a Lean management system and its effectiveness thereby creating interest in the individual to investigate further.
- Someone attends a conference and a Lean management system case study is presented.
- Someone in top management hears about the Lean management system and assigns someone to look into it.
- Someone who is experienced in Lean management system joins an organization that has not been using Lean tools and methods.
- An employee takes the initiative to read a book like *Lean Management Handbook*.

In addition to these typical introductions to Lean management, a champion that is trying to generate interest in Lean management should become focused on a cross-section of employees at several levels in the organization. This campaign should include enough senior managers or executives to assure acceptance of the organizational master plan when completed. Seek out senior managers that have existing backgrounds and beliefs in Lean or other process improvement techniques. In addition, mid-level and department managers need to become engaged, interested, and supportive of how a Lean management system can provide a foundation to achieve organizational objectives from both a strategic and a tactical implementation standpoint. Finally, a cross-section of supervisors and key frontline staff need to envision how a Lean management system will improve their daily environments.

Activity 2: Search for Knowledge on Lean Management Systems

There are many ways that an individual can obtain a basic understanding of the Lean management system methodology and how effective it is. Some of these are as follows:

- Attend a conference on Lean management system
- Read books on Lean management system
- Take a class on Lean management system

- Getting data from Internet
- Getting a consultant to explain how it can be applied to the organization

Activity 3: Conducting the Lean Management System Assessment

The focus of this activity is to conduct the LMA and then use that as a foundation for the development of your organizational master plan. The LMA is organized into nine sections.

1. Lean management philosophy
2. Educational system
3. Socio-technical system
4. Change management system
5. Product or service quality
6. Supply chain management
7. Management created measures
8. Operations created measures
9. Preventative maintenance

Each section contains a series of questions designed to gage both current Lean management capabilities and identify critical weaknesses that will need to be built into your organizational master plan. The data derived from the LMA will provide a foundation that visually and quantitatively describes the following:

- Where the organization currently stands with respect to Lean management
- Establishes a set baseline Lean measures on which all future Lean management activities can be measured and progress toward the goal of a comprehensive Lean management system measured
- Acts a platform for selling management on the need for and value of installing a Lean management system

Based on the LMA results, further analysis may be required to adequately define organizational weaknesses. Several tasks may include

- *Task 3.1:* Identify gaps between current organizational activities and LMA criteria.
- *Task 3.2:* Evaluate the nature of your current socio-technical system.

- *Task 3.3:* Evaluate the scope, if any, of your current Lean educational system.
- *Task 3.4:* Evaluate the organizational acceptance of change and your current Lean change management system.

Activity 4: Analyze Application of Lean Management System (Conceptual Evaluation)

During this activity, the individual should describe how the Lean management system concept works within your organization. The late Peter Drucker is our foremost authority so far on *management*, and he tells us, "The essence of management is not techniques and procedures. The essence of management is to make knowledge productive." This is a pretty good place to start as a definition that probably covers *Lean management* as well as any management. However, if Lean thinking means a different approach to business, then it must also imply a different approach to managing by the people striving to operate in a *Lean* way that would result in improved organization's performance. This does not require a detailed study, but just a conceptual evaluation.

In short, Lean management is very much about asking questions and trying things, or encouraging others to try things. Lean management itself is not much about providing the right answer, but it is very much about asking the right question. "The scientific mind does not so much provide the right answers as ask the right questions" (Claude Levi-Strauss).

Activity 5: Prepare Management Report (Deploying a Lean Management System)

Use the information gathered in Activities 1 through 4 to prepare a management report on Deploying a Lean Management System. The report should present the details of Phase I activities. These would include the following:

- Results LMA and where the company currently stands
- Both typical and specific results of organizations implementing Lean management systems
- Estimations of the impact a Lean management system may have on your organization
- A general plan on the implementation of Phases II through VI activities

Our own view of management comes from a little more than 10 years of experience working with companies like Ford, combined with about 15 years of working with many clients who try to understand and use those principles and practices. I am not sure which experience has taught me more—learning directly from Toyota, or trying to help others learn what I learned at Ford and the Oakland Quality Council, with which GM and Chrysler were also involved.

Particular emphasis should be placed on the role the executives need to play to be sure that a Lean management system will work within the organization.

Activity 6: Present Findings to Top Management

During this activity, present a summary of report contents to the top management. It is important that the management team understands that a Lean management system is an operational philosophy, not a set of tools. They will also need to change the way they operate if the project is to be successful. If top management does not accept its responsibilities to lead the Lean management system change initiative, there is a low probability that the project will be fully successful. The spirit of Lean management says that this approach is consistent with the critical Lean management principle of not jumping to solutions. Lean management is not about quick answers, but about going through a thinking process to investigate, analyze, and understand. To try, perhaps to fail, and learn.

The objective of this activity is to get consensus to proceed with the remaining phases of the organizational master plan.

PHASE II: DEFINE OPPORTUNITIES WITHIN THE ORGANIZATION

During this phase, the study team will quantify the impact that installing a Lean management system could have on the organization's performance, culture, customers, and employees. It will also develop a cost–benefit analysis. They will also define what the organization's key controllable factors (KCFs) are and develop word pictures (as-is statements) that define the present status of each of the KCFs. That statement captures the core spirit of Lean management just as it also embodies the spirit of learning. And

unfortunately, traditional management all too often lacks that very spirit. Traditional management places tremendous pressure on individuals to be right. You must have a solution, must know the answer. That sounds good enough on the surface. Who wants to be *wrong*? But that attitude starts us down a familiar and dangerous path. Hiding problems is endemic in almost every company that we know and is the surest way to absolutely undermine the practice of effective Lean management. Exposing problems, developing countermeasures, and learning from them does not just support Lean management; it is Lean management at its core value.

Definition: Key Controllable Factors (KCFs), which are sometimes called Key Business Drivers (KBDs), are the things within the organization that management can change that control and/or influence the organization's culture and/or the way the organization operates. (e.g., the way management lead and supports their employees or the organization inter face to its customers.)

The impact that a Lean management system could have on the key performance indicators and strategic business plan will also be analyzed. If the results from this study are favorable, the top management team will assign a project manager, approve a project team to do Phase III, and provide a budget for Phase III. The six activities that make up Phase II are as follows:

- *Activity 1:* Define the KCFs and develop as-is statements for each
- *Activity 2:* Conduct a study to define and quantify the opportunities
- *Activity 3:* Compare to present–approved–improvement plan projects to be sure there is no overlap
- *Activity 4:* Present the results to the top management
- *Activity 5:* Assign a project manager and project team
- *Activity 6:* Approve Phase III budget

Activity 1: Define the Key Controllable Factors and Develop an As-Is Statement for Each

There are many things that are outside of the organization's management control. They cannot control what the competition is going to do. They cannot control the ups and downs of the economy. They cannot control the value of the dollar, and so on. However, there are a few things that they can control, which define how the organization will function. These are things that the organization can invest in to change the way the organization works and the results of its activities. It is important that the organization defines these

KCFs and how they want to improve each of them over the next 3–5 years. Like most great models or constructs, Lean management is no different as it needs to stand on a solid foundation. Everything starts from a simple equation that can be understood by everyone, called the breakthrough equation. The equation is $Y = f(X) + \mathrm{E}(\varepsilon)$, where Y is the output, the results you want or expect, X is the input, the factors needed to produce output, f is a function, that is, a way or process in which inputs are concatenated into the output, and E (called epsilon) is the error factor, the uncertainty of inputs (X) or process functions (f) that produces output (Y). The simple equation is also called a phenomenal breakthrough equation. In other words, some input is transformed by some process into output. The result Y is a function of X. To set your desired output transformation process of inputs. To produce a better Y, you must perform problem solving on the Xs. The fact that some Xs exert more cross Y impact than others leads to the breakthrough concept.

KCFs are sometimes called key business drivers. In most organizations, there are between 8 and 12 KCFs. Typical KCFs include the following:

- Management leadership and support
- Customer interface/relationship
- Employee education and training
- Process operations
- Supplier partnership
- Knowledge management

For the common KCFs, maturity grids have already been developed, which allows an organization to quickly define the as-is state (Figure 14.1).

Key Change Areas: Lean Maturity Grid

1. Management Support/Leadership

Scale

1. Managers give orders. Employees are responsible for following them exactly without question. Management gets credit for all successes; employees are blamed for failures.
2. Managers give orders. Employees are responsible for following them exactly, but are allowed to question them. Employees are blamed when they do not follow orders.
3. Managers are responsible for results; workers respond to the directives of management.
4. Managers recognize the need for change. Recognition/rewards begin to be a part of the motivation process. Managers start looking for and praising people who do the right things right.

5. Managers create a vision of the preferred future, which leads to group development of the *mission*. An organization-wide plan for achieving the mission has been developed. All managers are trained in participative management techniques. Teams are formed to work on problem solving and improvement opportunities.
6. A continuous improvement process is launched; team building and problem-solving training are provided to everyone. Managers recognize the need to be process oriented. In reflecting on the past 10 years, one significant observation is that consistent action-learning is rare, and that reflection remains the weak link for most of us. Therefore, I am particularly pleased to read about Dr. Kano's reflections number and mental illustrations in his 2010 issue, and am looking forward to learning from him once again. I have written to him about how people are using Lean tools and philosophy, as well as methods from scenario planning to embed learning in our everyday processes. They demonstrate the positive results that come from a focus on bringing out the best in people as standard practice. We need to learn and understand more about the great Dr. Kano. He is indeed one of the true grand masters alive today. At Florida Power and Light Company, we came to know him as the developer of a customer satisfaction model (now known as the Kano model), whose uniquely simple ranking scheme distinguished between essential and differentiating attributes related to the concepts of customer quality that we were learning and practicing at that time. Progress has been made in building pride of accomplishment and self-esteem. Supervisors and managers are selected based primarily on their leadership ability.
7. Managers begin teaching, coaching, and working with their people on continuous improvement. Managers are treating quality and productivity as one. There are numerous examples of team building. An error-free performance standard is being used.
8. Management is working to change systems/processes, which their organizations have identified as barriers to achieving the organization's mission. Management by Walking Around is actively practiced. All employees are active members of a team. Supervisors, and their teams, to improve, use employee surveys.
9. Managers tailor their organizations to facilitate continuous improvement. quality and productivity performance levels and improvement *projects* are routinely reviewed with teams/individuals. All employees' output quality is measured and reported back to them.
10. Managers implement appropriate situational leadership concepts to stimulate groups and individuals in their groups in the implementation of a continuous improvement process. Managers are using statistical thinking. Teams are starting to set work standards. Promotions go to the people who prevent errors. A 5-year plan that includes improvement activities is defined and understood by all.
11. Recognition and rewards clearly flow to those who are using a continuous improvement process. Firefighting is left to lower management and employees. Upper and middle management spend much of their time working with employees in their work areas, talking to donors, or doing long-range planning.
12. The culture includes the effective use of a continuous improvement process to continually improve quality, productivity, and employee morale. Workers are responsible for results; managers are responsive to their needs. Long-term quality goals are understood and supported by employees. Employees are setting their own time standards. The majority of management time is spent preventing errors.

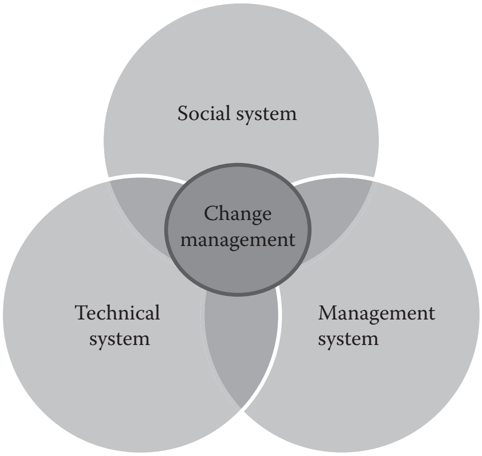


FIGURE 14.1
Change management—the key to blending together social, technical, and management systems.

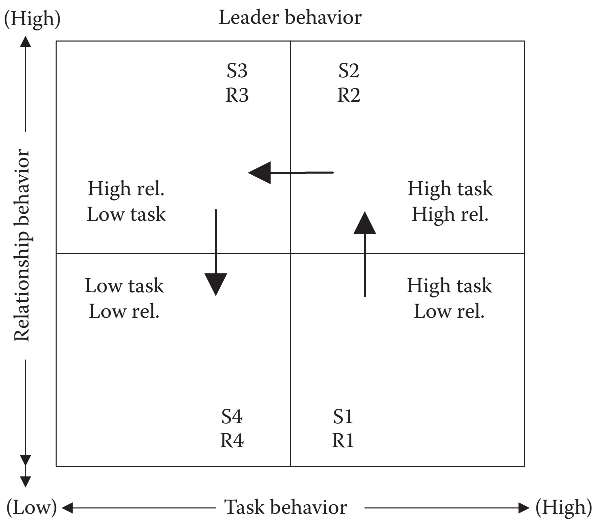


FIGURE 14.2
Maturity grid for management support/leadership.

The Lean Maturity Grid survey (Figure 14.2) is taken by the executive/senior management team and is used to define the *as-is* state as well as to get the executive team thinking about what the future could look like. This concept is taken from the *Organizational Master Plan Handbook*.[1] It is usually presented as an off-site meeting where the executive team

developed preliminary vision statements that define the future culture of the organization.

Simply by selecting the statement that best describes where the organization is today and selecting a statement that reflects where the specific KCFs should be 3–5 years in the future, the organization has created a rough gap analysis. In practice, we like to have the future state vision statements created in a customized fashion by the management team with inputs from the employees. Usually, the as-is statement from the maturity grid is adequate to define the current state of organizational awareness. With a rough gap analysis of your Lean culture regarding the KCFs, you are now ready to begin qualifying opportunities for improvement.

After the surveys have been conducted, the results are used to define the as-is state and as part of an off-site meeting with the executive team; the key phrases in the maturity grid are used to help develop the future vision statement for each of the key business drivers. These are preliminary statements that are then taken and reviewed with focus groups of employees, suppliers, and customers to get their input. A second meeting is held where the final vision statements of how the culture should develop over the next 5 years is finalized. These vision statements are then used to develop action plans to address the current problems and the potential roadblocks to moving forward.

Activity 2: Conduct a Study to Define and Quantify the Opportunities

Before the study team can successfully complete this activity, they need to understand what a Lean management system is and how to use the Lean tools. This is best accomplished by having a consultant conduct a class on Lean management systems with the total study group in attendance. Often the consultant will also stay with the study team to help through Phase II.

Once the study team has a basic understanding of what a Lean management system consists of, they can start to apply the different tools and approaches to each of KCFs. This will allow them to define which of the Lean management system tools and methods will help to bring about the desired transformation in the KCF. This is not very practical and is nor good advice. All technological devices require systems integration in one form or another. Some designs do a better job than others at integrating all their parts. Of course it all depends on what we consider better. You might want to use a big fan to create a powerful wind effect in a movie. Or you

might want a small fan to fit into a laptop computer to cool it off. You might not care whether the fan makes a lot of noise or you might require a very quiet fan. How the device or tool will be used makes a big difference in how its parts should be integrated.

The study team should then review the organization's operations to define which tools and approaches are applicable to the different function. In addition, they will need to collect data to define the improvement opportunities and to be able to estimate the impact that the selected Lean tool/approach will have on improving the organization's performance. These are rough estimates as the real detailed analysis will be conducted during Phase III. Typically, with a return on investment (ROI) of three to one or greater, it is usually worthwhile continuing the project.

Activity 3: Compare to Present–Approved–Improvement Plan Projects to Be Sure There Is No Overlap

The study team should then compare their recommendations to the other already-approved projects to be sure there are no two or more projects addressing the same opportunity.

The strategy development process starts by asking the following questions: How does your organization conduct its strategic planning? What are the key process steps? Who are the key participants? How does your process identify potential blind spots? How do you determine your core competencies, challenges, and strategic advantages (identified in your organizational profile)? What are your short- and long-term planning time horizons? How are these time horizons set? How does your strategic planning process address these time horizons?

If other approved projects are directed at improving the same opportunity, the study team should meet with the project management of the approved project to define if there is a need for both of the projects. All too often overlapping projects decrease ROI for both projects resulting in little or no real benefits.

Activity 4: Present the Results to Top Management

The study team should prepare a report that defines the scope of the assignment and their recommendations related to installing a Lean management system. If the study team recommends that a Lean management system project should be formally implemented within the organization, the report should also include a preliminary mission statement for the project

and improvement objectives. This report should be presented to top management and should be discussed thoroughly to be sure that top management understands its role in the transformation before a final decision is made related to establishing a formal Lean management system project.

Activity 5: Assign a Project Manager and Project Team

If the top management decides to initiate a formal Lean management system project, they should appoint a project manager who will be in charge of managing the project. In some cases, the project manager is given the latitude to select the members of the project team. In other cases, top management will assign the project team members. It is important that both the project manager and the project team members are relieved of some, if not all, other assignments so that they have time to dedicate to the Lean management system project. All too often organizations assign Lean management system projects to individuals without relieving them of any of their other responsibilities. When this occurs, what management is really saying that they believe that the individuals do not have a full-time workload at the present time and as a result, they can absorb additional work without interfering with their current daily activities. In many cases the project management job is a full-time job and the project team members will be working at least 25% of their time on the project. Many of them will be working a minimum of 50% of their time, depending on the size of the organization and the complexity of the implementation.

Activity 6: Approve Phase III Budget

Once the project manager is assigned, he/she will work with the study team to develop a detailed budget to support Phase III activities. This budget should be approved by top management and a special account should be set up to track charges related to the Lean management system project.

PHASE III: DEVELOP THE IMPLEMENTATION PLAN

During Phase III, a detailed project plan will be developed and approved. This plan will include the following:

- Business plan
- Business case

- Work breakdown structure
- Project schedule
- Project budget
- Quality plan for the project
- Measurement plan for the project
- Objectives and goals for the Lean management system and its total impact on the organization
- Communication plan
- Risk analysis plan
- Cost–benefits by analysis by individual Lean management system approach and as a total system
- Resource plan
- Change management plan

It is important to note that the project plan must be supportive of the organization's business plan and strategic business plan so that it will be included in the annual operating plan. The Lean management project plan will make up a big part of the strategic improvement plan. Describe how your organization converts its Lean management objectives into action plans. Summarize your organization's action plans, how they are deployed, and key action plan performance measures or indicators. Project your organization's future performance relative to key comparisons on these performance measures or indicators. Within your response, include answers to the following questions:

1. What are your key short- and long-term action plans? What are the key planned changes, if any, in your processes, your customers, and markets, and how you will operate?
2. How do you develop and Lean plans throughout the organization to your workforce and to key suppliers and alliance partners, called comakers, to achieve your Lean strategic objectives? How do you ensure that the key outcomes of your Lean system can be sustained?
3. How do you ensure that financial and other resources are available to support the accomplishment of your plans, while meeting current obligations? How do you allocate these resources to support the accomplishment of the plans? How do you assess and manage the financial and other risks associated with the plans?
4. How do you establish and deploy modified action plans if circumstances require a shift in plans and rapid execution of new plans?

5. What are your key human resource or workforce plans to accomplish your Lean management short- and long-term strategic objectives and action plans? How do the plans address potential impacts on people in your workforce and any potential changes to workforce capability and capacity needs?
6. What are your key Lean management performance measures or indicators for tracking the achievement and effectiveness of your plans? How do you ensure that your overall plan measurement system reinforces organizational alignment? How do you ensure that the measurement system covers all key deployment areas? (See Figure 14.3.)

During Phase II, the KCFs for the organization were identified and their as-is situation documented. The team also defined the Lean management system tools that would improve the performance for each of the KCFs. Now in Phase III, the project team will develop a vision statement for each of these KCFs that describes how it should change over the next 3–5 years. The team will then select the Lean approaches that will bring about the required change in each of these KCFs and schedule how these approaches will be rolled out into the organization during the next 3–5 years.

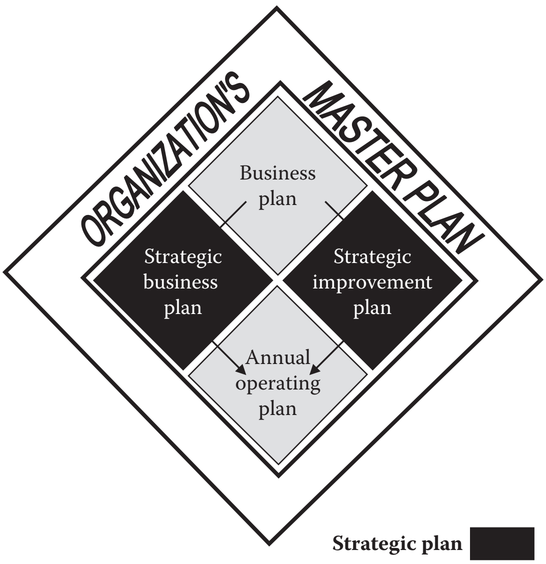


FIGURE 14.3
The five parts of the organization's master plan.

The following are the nine activities that make up Phase III of the Lean management system planning cycle:

- *Activity 1:* Develop vision statements for each of the KCFs
- *Activity 2:* Define desired behaviors
- *Activity 3:* Prepare individual improvement plans
- *Activity 4:* Combine the individual improvement plans
- *Activity 5:* Prepare a cost–benefit analysis (ROI)
- *Activity 6:* Develop a set of performance goals
- *Activity 7:* Prepare the Lean management system's project plan
- *Activity 8:* Present the Lean management system's project plan to management
- *Activity 9:* Include the Lean management system's project plan in the strategic business plan and the organization's annual operating plan

Activity 1: Develop Vision Statements for Each of the KCFs

During this activity, the executive team develops a vision statement of how they would like the organization to be functioning related to each of the KCFs 5 years in the future. These first draft vision statements are then presented to the organization's stakeholders for their comments and suggestions. Based on these inputs, a set of 8–12 vision statements are revised and finalized. Now, the gap between the as-is and vision statements for each of the KCFs can be defined. One tool that can be used here is a 5-year transformation map. This is a map that can visually show how the improvement plan should drive the KCFs in a positive fashion out into the future.

Activity 2: Define Desired Behaviors

Improvement in culture and performance requires changes in the behavioral patterns of the management team and its employees. The organization's behavioral patterns need to change before the desired results can be accomplished and measured. A set of behavioral patterns required to transform the organization so that it is in line with the organization's vision statements is identified. What are the Lean management behavior patterns?

Activity 3: Prepare Individual Improvement Plans

During this activity, a team will address each of the vision statements and define the problems related to the vision statement that the organization

is facing today. Then they will make a list of the roadblocks that the organization will face in making the transformation. Once these are defined, the root causes for each of the problems and roadblocks will be identified. For each root cause, the team will review the list of tools and methods that make up the Lean management system to define which of these tools can be used to overcome the obstacle. A list of some of the most commonly used tools and methods are presented in Appendix A. Descriptions on how to apply many of these statistical and nonstatistical tools can be found in *Lean Six Sigma Black Belt Handbook*.*

The team will also review the list of Lean improvement opportunities that the study team defined and define the Lean tools/methods that can be used to take advantage of these improvement opportunities. These two lists are combined and prioritized to define the Lean tools/methods that will be used in the project. The team will also define the cost and resources required to implement the selected tools/methods and the impact it will have on the key measurements.

Activity 4: Combine the Individual Improvement Plans

You may question why we are talking about a 3- to 5-year plan. A good strategic business plan is usually based on a 5-year period and our project to implement a Lean management system should be part of the strategic business plan and support it. The Lean management system needs to be implemented and synchronized with the strategic plan if it is going to last. In addition, all organizations already have a full workload on their plates. We must be very selective about the amount and kind of change that is introduced into the organization. It is much better to go a little slower and take time to win the support of your employees than to push change so fast that it drives the organization into future shock. It is our experience that one of the hardest things to get management to do at this point in the project is to put off doing something for a year or 2 that they believe will be beneficial to the organization now. The biggest mistake that is made at this point in the project is planning to do too many changes during the first year. We strongly recommend that the combined plan be designed to at least break even after the first 6 months and then have a very favorable ROI for the rest of the project.

* There are a wide range of tools for process improvement available. *The Lean Six Sigma Black Belt Handbook* (CRC Press/Taylor & Francis Group) presents a range of statistical and nonstatistical tools.

Activity 5: Prepare a Cost–Benefit Analysis (ROI)

The project team should now prepare a projected ROI based on the output from Phase III Activity 4. At this point, the estimate needs not be more than plus or minus 30% accurate.

Activity 6: Develop a Set of Performance Goals

In this activity, the project team develops a set of performance goals that the Lean management system should drive annually for the next 5 years. The yearly goals are used to measure progress. The Lean management performance goals and objectives should meet three requirements: (1) They should be customer focused, (2) they should be measurable, and (3) they should be appropriate for the company vision. You can select as many as are appropriate. These goals should be maintained on a controlled document that is printed and posted around the facility. The organizational performance of these measures should be reviewed at every management review meeting.

Activity 7: Prepare the Lean Management System's Project Plan

The project team is now ready to put together the total package into a formal project plan. This plan usually consists of charters for other subproject plans that will be used to implement key elements of the Lean management system. The project team will also prepare a budget for the Lean management system.

Activity 8: Present the Lean Management System's Project Plan to Management

The project team will present the project plan and the supporting budget to the executive team. If management is satisfied with the budgeting and the ROI, the plan should be approved, which officially brings the project into a portfolio of projects going on within the organization.

Activity 9: Include the Lean Management System's Project Plan in the Strategic Improvement Plan and the Organization's Annual Operating Plan

By including the Lean management system project plan and budget in the strategic improvement plan and the organization's annual operating plan,

resources are assigned and the project is tracked as one of the organization's initiative.

PHASE IV: IMPLEMENT THE LEAN MANAGEMENT SYSTEM PLAN

During this phase, you transform your planning into profit. All too often we spend the time required to do the planning, but the plans never get implemented or get implemented poorly. Over 80% of the failures of Lean management, Six Sigma, and total quality management (TQM) are related to poor implementation approaches. Time after time we have verified that it is not the tools that are the problem—it is the way they are applied. The implementation phase is where the rubber meets the road; it is for this reason that we recommend that the organization ensures that the required resources are available and budgeted. It is also the key point in the Lean management system implementation where upper management needs to be demonstrating its full support of the project by changing their behavioral patterns.

This phase is made up of nine activities. They are as follows:

- *Activity 1:* Assign implementation teams
- *Activity 2:* Define what will be done with surplus people
- *Activity 3:* Assign a project manager to all stand-alone projects starting in the next 6 months
- *Activity 4:* Measure and/or define the as-is status
- *Activity 5:* Form and train the implementation project team and the subproject team members
- *Activity 6:* Conduct an organizational change management assessment and develop appropriate mitigation plans
- *Activity 7:* Train the people who are impacted by the change
- *Activity 8:* Implement the change
- *Activity 9:* Conduct Phase III tollgate

Activity 1: Assign Implementation Teams

Often Lean management system projects are divided into subprojects as different approaches and tools are implemented in different sequences in

different areas. For example, usually it takes much more work to apply 5Ss to a production department than to a financial or sales area. The whole supply chain focus requires a long-term Lean focus that is unique until itself. As a result, the project team will usually define subproject implementation teams to make the required transformation in the individual part of the organization or for specific tools. From this information, identify and describe what makes all the subsystems work together. How do the subsystems affect each other? What monitors the functions? What are all the factors involved in making it work together? In other words, think systems integration! These individual implementation teams will prepare their own work breakdown structures and integrate them into the master project plan.

Activity 2: Define What Will Be Done with Surplus People

The focus of a Lean management system is the elimination of waste that burns up the organization's resources. Eliminating waste reduces the effort required to perform the individual activities within the organization. In many processes, the use of Lean tools and methods has resulted in reducing the amount of effort to complete a task by 50% or more, which in turn results in surplus personnel. This can have a disastrous impact on the organization's morale and employee loyalty unless very careful consideration has been given to how handle the freed-up resources. All too often these surplus people are just let go or they are reassigned to activities that previously were not performed. Logically if we were not performing these operations and things were running acceptably, these are activities that need not be done and reassigning people to these activities is the wrong thing to do unless there is a measurable ROI. If management has not given any thought to how these surplus employees will be handled, now it is too late. Planning for surplus employees should start when the project is initially approved.

Frank Popoff, Dow Chemical Company, stated: "Layoffs are terribly expensive and destructive to shareholder value."

It is unrealistic to expect employees to give freely of their ideas and how to eliminate waste if it will result in losing his/her job or any of their friends losing their jobs. As a result, many companies have developed no-layoff policies. A typical one would read: "No one would be laid off because of productivity or quality improvements. People whose jobs are eliminated will be retrained for an equivalent or more responsible job. A no-lay off policy doesn't mean that it may not be necessary to lay off employees because if business downturns."

In 1991, Bill Clinton, then Governor of Arkansas, signed a bill ensuring that no state employee would lose employment because of quality management effectiveness.

Because there is usually a delay between when improvement in quality and efficiency occur and before increased customer demand will grow to the point that it fills in the voids, management must look for alternative ways to use employees before laying off employees is even considered. Typical alternatives to layoffs are as follows:

- First look to move employees from no-value-added activities to value-added activities that will generate enough additional revenue to make a profit from the work activity.
- Conduct Kaizen (remember Toyota's response to adversity in Chapter 4).
- Overtime reduction.
- Skills training.
- Attrition by freezing hiring.
- Using them to do training.
- Increased marketing and sales effort.
- Voluntary leaves.
- Job rotation.
- Incentive retirement programs.
- Shorter work week.
- Sending them to external schooling.
- Job sharing.
- Assigning them to several programs, and so on.

The authors agree that there are occasions when there is no other option except to lay employees off; but this should not be considered until all the other alternatives have been exhausted. The matter of surplus employees is a serious issue and must be addressed in a very competent and professional manner.

Activity 3: Assign a Project Manager to All Stand-Alone Projects Starting in the Next 6 Months

Each of the subprojects/standalone projects should have a project manager assigned to it who is held responsible for keeping it on schedule within projected costs and ensuring that it produces the desired results.

Activity 4: Measure and/or Define the As-Is Status

One of the biggest mistakes when implementing a change is that they do not take time to measure how the present process is performing before the change is implemented. It is absolutely imperative that the implementation team and the project team agree on how the impact of the improvement activities will be measured, and they must collect enough data related to the present operations so that the baseline for the improvement is established and agreed to before any changes are implemented.

Activity 5: Form and Train the Implementation Project Teams and the Subproject Team Members

All of the implementation project team and subproject team members need to have an excellent understanding related to the Lean tools and methodologies that they are implementing. They not only need to be trained so they understand the Lean tools, but they need to be convinced that the Lean management system is the right approach for the organization. None of the implementation team members can be unsure that they are doing the right thing for the organization and its employees. A negative attitude by any of the implementation team members related to the benefits of the Lean management system and its positive impact on the employees can cause a contagious disease of uncertainty, distrust, and rebellion to spread throughout the organization like wild fire.

Training of the implementation team members includes the following:

- The tools and methods that they will be using
- The technology that will support the processes
- Organizational change management
- Team building
- Requirements for a Lean management system to work in an organization

Usually we do a fairly good job of training the implementation team in the part of the processes that they are responsible for and the technology that they will be using. However, this is far from adequate. They need to understand how their efforts feed into the total picture and how the organization and the employees will benefit from these activities. But even that is not enough. They also need to be change agents—very few technical

people have the training and/or the ability to be effective change agents and as a result, the changes that they implement never perform at their true potential.

The underlying principle of making continuous improvement happen is that we are unlikely to improve learning outcomes and productivity until we define how to optimize and start measuring them.

This starts and ends with identifying what we seek in learning outcomes, and also requires getting a handle on the costs associated with components of our education system. Also, individual resources and activities come into play, so that the ratio of outcomes to costs can be tracked over time. As we establish new and more complete measures of learning and pragmatic outcomes, however, quality matters. Even if we cannot accurately measure or easily remedy qualitative differences, we must consider them as we determine what to measure for continuous improvement. There is a big difference between understanding a concept on an intellectual level and taking it to heart. The optimization mentality is key to the approach and while easy to grasp, comprehending its importance and implementing it on a day-to-day basis is not so easy after all. If it was, there would not be so many people wondering what went wrong.

Activity 6: Conduct an Organizational Change Management Assessment and Develop Appropriate Mitigation Plans

Every change activity will be faced with resistance to its implementation. It is normal and should be expected. In some organizations, there is a low level of resistance and there is little or no risk involved in the implementation of some of the Lean tools/methods activities. In another situation, the same tools or methods will meet with a high level of resistance and the risk of failure will be very high.

Embracing the optimization mentality is something everyone should strive for as every productive action is driven by the goal of continuous improvement. Ever notice that as soon as you accomplish a goal or reach a new level of improvement, you immediately want more? I am convinced the enjoyment and satisfaction we get out of life has everything to do with the challenge and struggle—not the eventual result or goal. People do not do goals, they do actions and activities, enjoy the challenge, and respond to the struggle within.

We first have to agree on what *culture* is—and concurrently understand what causes people to oppose change; this *can* be clearly explained,

and such understanding can be used to massively benefit change initiatives, such that people become comfortable with change, culturally. The problem is that, to *clearly explain*, words that are uncommon to leaders of business or change are required. Such *new* language is pigeon-holed as *psychology* and therefore is often seen as having nothing to do with business. Because of the *threat/fear* response, triggered when faced by something (anything) *new*, our deeply imprinted defense mechanisms (fight/flight reactions) are stimulated. The result is that we subconsciously oppose what is new, that is, change. To approach change with conscious awareness of the *People process* (i.e., the systemic provocation of an unconscious and cultural opposition to change) requires the leaders of a change program or of an organization, understand such things as *collusion and cognitive dissonance* (among many other principles regard the *people process* in respect to change).

By conducting an organizational change management assessment related to each implementation team's assignment, the level of resistance and kind of risks that are involved can be defined. Those elements with medium to high risk associated with the different considerations should have mitigation plans prepared for them by the implementation team that will minimize these risks.

Activity 7: Train the People Who Are Impacted by the Change

It is imperative that the people who are directly affected by the change be involved in defining how the change is implemented. This means that they should receive training related to the new process as early as possible in the cycle. The implementation team should try to include as many of the suggestions that are made by those impacted who will be living with the change as possible in the final process.

Activity 8: Implement the Change

As we get ready to implement the change, it is often advisable to run a pilot program first to ensure that all of the potential bugs have been removed from the process. When you do a pilot, we recommend that you run a control sample along with the new process sample. This will allow the implementation team to have comparable data. When all of the paperwork and training is complete, it is time to make the changeover. The implementation team should be located in the affected areas during the

implementation phase so that they can see the problems first hand and react quickly to make corrections and to quickly bring the situation under control.

Activity 9: Conduct Phase IV Tollgate

This tollgate is a complete review of the project to date to be sure that the project had evolved to the point that it should go to Phase V. This review is conducted with upper management. As a result of this meeting, upper management will determine if additional work needs to be done on the project or that the project has completed the first four phases and is now ready to move into Phase V.

PHASE V: MEASURE THE RESULTS

This is where we find out the real value of the processes that the Lean management system project team created. Remember that there are two parts to these measurements: hard data measurements (like cycle time and cost data) and human behavioral observations (like increased participation and increased initiative). We find usually that behavioral changes occur first, followed by the hard data changes. The behavioral observations are more short-term types of analysis and usually are more subjective. Growth and development should be one of the five main strategic fields of an organization. I count one more than the balanced scorecard counts:

1. Growth and development of people and organization
2. Dynamic strategic development (it is new but necessary because of quick changes in the market)
3. Marketing strategy
4. Organization strategy
5. Resources strategy

All five strategy fields have to contribute to fulfill the company mission. They all contain underlying levels from strategic solutions till operational implementation. Einstein teaches us to solve problems at a higher level of abstraction. I believe in starting with the mission. The ultimate goal or like Robert Hargrove calls "The impossible future." It should not be a treat but

a challenge for all individuals in the company. It is a future where a company and his people will grow and develop to. It is necessary to make the difference in the market competition. But nobody is condemned. Everyone will be challenged to participate or is free to step out.

The hard-data system is more stable and will be used for a longer period of time. It is important that the hard-data system has the following characteristics:

1. Measurement is made close to where the act is performed.
2. Measurement sample is large enough to have a good insight into the total population.
3. Personal opinion-type measurements should be minimized.
4. Try to have measurements that reflect the external customer's needs.
5. Select measurement that supports the organization key performance indicators.

As you develop your Lean management data system, remember the 11W's:

1. Why you should measure?
2. Where you should measure?
3. What you should measure?
4. When you should measure?
5. Who should be measured?
6. Who should do the measuring?
7. Who should provide feedback?
8. Who should audit?
9. Who should set business targets (standards)?
10. Who should set challenge targets?
11. What should be done to solve problems?

Measurements are critical to

- Understanding what is occurring
- Evaluating the need for change
- Evaluating the impact of change
- Ensuring that gains made are not lost
- Correcting out-of-control conditions
- Setting priorities

- Deciding when to increase responsibilities
- Determining when to provide additional training
- Planning to meet new customer expectations
- Providing realistic schedules
- Satisfying your stakeholders

The following eight activities are part of Phase V:

- *Activity 1:* Define what measurement should be affected by each of the Lean management system projects.
- *Activity 2:* Define *what, where, and how* improvement will be measured.
- *Activity 3:* Define how changes in behavioral patterns will be observed.
- *Activity 4:* Develop and implement the reporting system.
- *Activity 5:* Train the related personnel in how to collect data.
- *Activity 6:* Collect and analyze the data.
- *Activity 7:* Conduct the Phase V tollgate.
- *Activity 8:* Reward the installation and Lean management system teams based on their Impact.

Activity 1: Define What Measurement Should Be Affected by Each of the Lean Management System Projects

Each Lean management system subproject will have its own impact on the organization's performance. It is important to be able to understand the benefits that are realized from each of these Lean management system subprojects. In some cases, the total impact of a specific improvement concept has not produced satisfactory improvement to justify continuously using the concept, although the overall impact of the Lean management system was very positive. Often two or three different subprojects target improving the same thing and after one subproject is implemented, the problem is solved and there is no need to implement the other one or two subprojects.

Activity 2: Define What, Where, and How Improvement Will Be Measured

The measurement plans need to be implemented before the changes are implemented, so there is a firm base for measuring improvement. This is the baseline for the improvement that should have been completed

during Phase IV Activity 4, but often it is necessary to put in some special measurements so that the effectiveness of individual tools and/or methods can be evaluated. In other cases, the process has changed to the point that the normal measurement system that will be used to control the process after the change is implemented will need to be upgraded.

Activity 3: Define How Changes in Behavioral Patterns Will Be Observed

The Lean management system is designed to change behavioral patterns of the people within the organization. Often the change in behavioral patterns occurs before results can be measured. It is therefore important to define how these changes in behavior can be observed. For example, if the organization is empowering its people to make more decisions on their own, the resulting behavior is that the employees are asking fewer questions on how they should do their work and they are now telling management what they did to get their assignment completed.

Activity 4: Develop and Implement the Reporting System

It is important to define how the measurement data will be used and the amount of data that will be required to be able to make an informed decision. No data should be collected unless there is a use for it. As a result, the reporting system will define the format of the data collection system, the frequency that the data will be collected, and the quantity of data that will be collected.

Activity 5: Train the Related Personnel in How to Collect Data

The old saying, “Garbage in and garbage out,” is a reality. It is therefore absolutely imperative that the personnel who are collecting the data are trained so that the people analyzing the data and the management team can have a high degree of confidence that it is accurate and not misleading. Knowledgeable personnel should train the individuals who will be collecting the data on how to collect it and observe them during the initial phases to be sure they have not misinterpreted any of the instructions.

Activity 6: Collect and Analyze the Data

These activities start before the Lean management system changes are implemented to have a good baseline and will continue until enough data has been collected to measure the effectiveness of each of the subprojects and the total project. The results of this analysis should be documented in a formal report that is presented at the Phase V tollgate.

Activity 7: Conduct the Phase V Tollgate

This tollgate is used to evaluate the effectiveness of the Lean management system. If the result of the Lean management system project is satisfactory, the Lean management system project team and implementation teams will be disbanded as their assignments are complete. If the results are unsatisfactory, the decision needs to be made if the Lean management systems team needs to do additional work or should the project be dropped because it did not meet its objectives. In most cases, at this point in the methodology the project is complete and it is ready to have the responsibility of managing the Lean management system transferred back to the normal managers in the affected areas.

Activity 8: Reward the Installation and Lean Management System Teams Based on Their Impact

We recommend that the individuals, individual teams, and subteams be recognized and rewarded based on their contribution to the organization's performance. In some cases, it could be a simple thank you from their manager for the effort they put forth. In other cases, a gift or a financial reward is justifiable. The value of the gift or financial reward will vary based on the magnitude of the effort that the individual or team put into the project, the magnitude of the improvement, or the culture change of the organizations.

PHASE VI: CONTINUOUS IMPROVEMENT

Now that the Lean management system is installed and working, it does not mean that the job is done. As a result of the Lean management

system team's effort and the cooperation of the rest of the employees, a number of improvement should have been made. Now we need to hold the gains that were made and build on them so that the organization gets another 10%–15% in improvements each year. This means this is where we need to bring in the annual quality objectives to lock in and sustain the gains. The quality objectives should be meet three requirements. (1) They should be customer focused, (2) they should be measurable, and (3) they should be appropriate for the company vision. You can select as many as are appropriate. These goals should be maintained on a controlled document that is printed and posted around the facility. The objected should be reviewed at every management review meeting.

For example, let us take the case of a client organization in the *Maritime Industry.*

Customer Service: Provide all customers the best quality training and services possible consistent with available resources and serve as a resource center to analyze customer needs.

Regulatory: Design, develop, and conduct courses for personnel working in the maritime community that meet individual and company simulation, training, assessment, and research needs as well as being in compliance with the latest national and international rules, regulations, and guidelines.

Technology: Acquire, use, and apply the latest technology and information in the field of maritime training consistent with available resources in the development and delivery of simulation, training, assessment, and research.

Ethics: Conduct all business in an ethical and professional manner sensitive to human needs and social responsibilities to achieve our customers' goals and create opportunities for our employees.

Continuous Improvement: Identify and examine nonconformities in design, delivery, and customer service to determine processes that require improvement and implement necessary changes to continually improve.

Employee Acceptance: Create and maintain an environment that encourages teamwork, cooperation, initiative, leadership, problem solving, constructive decision making, fiduciary responsibility, and a commitment to continuous improvement.

Leadership: Provide expertise and input to industry and regulatory bodies that promotes the improvement of safety at sea, protection of the marine environment, and the overall betterment of the maritime community.

- New employees coming into the area will need to be trained in their role in the Lean management system.
- Performance standards need to reflect the Lean management system environment.
- Additional TQM tools and methodologies need to be selected and installed.

On occasion, we have been shocked when we return to a customer location 2 years after we had installed a Lean management system to find out that many of the concepts that were implemented were not being used. Many of the areas were almost as cluttered as they were when they started using the 5Ss; it looked like the clean desk policy had been completely ignored. Behaviors do not change overnight; it takes a long period of reinforcement before a new way of doing things can become a habit.

There are two activities that make up Phase VI:

- *Activity 1:* Sustaining the gains
- *Activity 2:* Ongoing improvement

Activity 1: Sustaining the Gains

All of the gains made by the Lean management system can be quickly eroded away unless effort is expensed to continue the practices that have been implemented. We liken it to a person who goes on a crash diet and takes off 30 pounds, and then goes back to his/her old eating habits and quickly puts back on 35 pounds. This will not occur with the Lean management system if adequate care has been taken to fully implement the organizational change management activities. By this point in the Lean management system methodology, the total management team should have been convinced that the Lean management system approach is the best one for the organization. In terms that are used in organizational change management, the managers in the affected areas need to have been converted to sustaining sponsors of Lean management system. In this role

they need to continue to reflect the Lean management system roles and practices in their personal work habits as well as their emphasis with the employees. In addition, people who come into the area need to be trained to understand the Lean management system approaches and concepts that have been applied to the jobs that they will be assigned to.

Activity 2: Ongoing Improvement

It is not enough to just hold the gains that were made while the Lean management system was being implemented. When you stop improvement, you do not stand still—you start slipping backwards because your competition is continuously improving. Everyone needs to search for new ways to cut out waste. Each individual needs to look for ways to implement creative improvements. Management needs to invest in the employees by providing them with on-going education and training. Everyone needs to know that they are expected to define new ways about how they can improve their job. Many organizations have trained and motivated their employees to the point that they are averaging two implemented suggestions/month per employee.

SUMMARY

Time after time improvement programs like TQM, business process management, Six Sigma, Lean Six Sigma, and Lean management systems have been classified as a failure by the organizations that have implemented them. At the same time, other organizations that are using the same improvement approaches and tools are writing articles and the top management is speaking at conferences explaining how these approaches are helping them to grow market and increase profit. There is no doubt in our minds that it is not the tools/methodologies, it is the way they are implemented and the way the management team supports the improvement approaches. All too often organizations have not treated performance improvement efforts as a major project. They expect the program to be implemented without a budget for the needed resources. They try to implement the improvement process with unskilled people. They think that it applies only to the worker and not to the manager. They do not use experienced project management or change agents. Prioritizing process

improvement at the top and engaging employees throughout the company are the best ways that we have seen Lean management systems work. At a major client company, the CEO has communicated a strategic plan that shows process improvement as one of three pillars that are the foundation of how we achieve our goals. The executives do process walks in which they sit with the employees to see how they do their work and to ask them how the work flows or does not flow well for the customer.

We solicit ideas from the frontline employees this way, through our pipeline, and through large group communication/training sessions. And we are sure to follow-through with responding about how we will or why we will not act on the ideas. We have several Kaizen events and green belt/black belt projects going on throughout the year and try to rotate participants from the front-line to (1) engage them in the process, (2) let them know they are empowered to help make important decisions, and (3) engage a large enough number of employees participating in the practices to sustain momentum. We have a front page link on our intranet for Lean and highlight *Lean leaders* helping to drive process improvement in their areas. And leadership sets goals that are tied to Lean and Six Sigma.

Tracking and publishing successful results also gets people excited, and process improvement is *pulled* by the organization, rather than *pushed* by process improvement teams. Embracing Lean management continuous improvement is certainly a culture change for most organizations. This definitely has to be embraced from the top down to be successful. We too have seen Kaizen events executed with great enthusiasm with a slow drift back to status quo over time. The greatest successes have been where there has been disciplined management follow up to ensure that new processes are maintained. As the saying goes "people respect what you inspect." Therefore, Lean management has to become engrained in the fabric of everyday work and not an add-on after the *real work* is done. This includes as mentioned above changing the reward structure. Lean initiatives would have to become a part of individuals' beliefs and behaviors. Management often wants to see improvements but they do not want to change their behavioral patterns to achieve those improvements. All of the improvement initiatives will produce excellent results if, and only if, they are implemented in a professional organized manner.

Do not waste your time and money implementing a Lean management system unless you are committed to changing yourself and the management team has agreed to using a realistic professional approach to implementing the Lean management system methodology. This needs

a better and more powerful summary. As previously stated, the spirit of Lean management says that this approach is consistent with the critical Lean management principle of not jumping to solutions. Lean management is not about quick answers, but about going through a thinking process to investigate, analyze, and understand. In short, Lean management is very much about asking questions and trying things, or encouraging others to try things. Lean management itself is not much about providing the right answer but it is very much about asking the right question. The underlying principle of making continuous improvement happen is that we are unlikely to improve learning outcomes and productivity until we define how to optimize and start measuring them.

REFERENCE

1. H. James Harrington and Frank Voehl, *The Organizational Master Plan Handbook*, CRC Press Taylor & Francis, Boca Raton, FL, 2012.

15

The Need for Facilitation

IN A NUTSHELL

The idea that helpers and educators are facilitators of learning and change has been around at least since the 1960s. It was the work of Carl Rogers in the United States and Klein (1961)[1] in Britain that brought the idea to the fore. However, the significance of facilitation and facilitators had already been recognized by some commentators on organizational life. Groups were becoming understood as the basic work unit of organizations, being used to plan and implement change and to organize work. It followed that interventions facilitating effectiveness—and reducing conflict—were fundamental to the interests of organizations. In this section, we look at the nature of group facilitation, values involved, and role of facilitators. We also examine some of the practical tasks and experiences of facilitating group sessions in a Lean management systems environment. In particular, we analyze and explore the need for facilitation, beginning a session, getting into the subject, responding to the moment, summing up and ending, and dealing with difficult behavior.

OVERVIEW

The meta-level Lean management system model is like a small but powerful engine in a high-performance car. Think Porsche. It generates tremendous horsepower from the efficiency of its design, coupled with the smooth operation of a well-functioning drive train. The transmission is the interrelated network of high-performing, cross-functional employee teams. They include the senior management team that creates the vision

and selects the improvement themes all the way down to the worker groups on the *floor*. The last part is the clutch, which is similar to team or group facilitation. Without facilitation, the transmission (and teams) does not engage.

Jackson and Jones (1996)[2] wrote at length about the role of these teams in the business renewal cycle and *catchball*, but they assume that organizations are blessed with skilled group leaders and well-performing team members. They described tools that teams can use but did not propose any training or development approach for the necessary facilitation skills.

Involving employees in strategy deployment is an active topic of strategic management, but it has been difficult to achieve in Western companies. The methodology known as Hoshin Kanri has proved to be an effective strategy deployment process in Japan where it has been extensively applied for integrating strategy and total quality management; but its adoption in the West has been low, except for a few innovative companies. The application of Hoshin Kanri relies on a process called catchball to gain consensus on the deployment of Hoshin targets and measures in a team environment. This chapter presents a process design based on an adaptation of the Delphi technique for the effective implementation of catchball, to reinforce the link between corporate strategy and annual planning cycle. The catchball process described was implemented at the Rover Group, a U.K.-based automotive company, to develop the company's quality strategy based on Hoshin Kanri principles.

Unfortunately, most of us have suffered through countless unproductive meetings that are rife with *meeting waste*. The endless delays and frequent errors are but two examples of *meeting hell*. Have you ever sat in a long meeting with high-level management and quietly tabulated the cost? Multiply that times the number of sessions down and across the typical organization on multiple, ongoing occasions. How can you develop a *Lean* organization with *wasteful* meetings in 3–5 years?

Most managers and supervisors do not run efficient meetings. They are promoted into these positions because they performed well in other duties and now they must engage their *staff* in meetings and group activities. This is especially challenging when they are tasked with implementing a new management system. Smart organizations recognize the value of this group facilitation skill set, and they provide extensive training. The reality in too many organizations is the exact opposite. New managers can either obtain the skills on their own or just continue to lead

inefficient, low-functioning teams. Staffs that do master the skills often find themselves in demand to help with *difficult* projects that need to be successful.

This chapter briefly defines facilitation and discusses related behaviors, tools, and techniques. The tool descriptions will be very basic because there are many in-depth treatments that can supplement this presentation. Recommended sources are provided in Appendix A. The authors will offer personal insights and suggestions from their years of practice. Many of the tips were learned the hard way, and some readers may have had similar experiences. If the insights resonate, adopt and share them with staff.

WHAT IS FACILITATION?

Most people associate the word *facilitator* with the traditional training environment. Often, the person at the front of the room leading a training session is referred to as the course or workshop facilitator. Although it is true that some seminar leaders do *facilitate*, the facilitation role is often important in other areas. For example, the chairperson at a meeting often takes on the responsibility for facilitating the meeting, rather than *running it*. The government employee involved in the mediation of disputes between other parties is also a facilitator. Human resources staff members often facilitate discussions in various contexts. And staff that work with groups of stakeholders and members of the public may be well advised to take on a facilitating role rather than a directing one.

For those of you who are already involved in facilitating, or those of you who may do so in the future, we are going to look at in this section what the facilitation role entails.

Some Basic Definitions

Webster's Online Dictionary defines *facilitate* as *to make easier* or *to help make it happen*. Synonyms include *ease*, *grease*, *loosen (up)*, *smooth*, and *unclog*. The antonym is *complicate*. Facilitators plan, guide, and manage a group event to ensure that the group's objectives are met effectively, with clear thinking, good participation, and full buy-in from everyone who is involved.[3]

A facilitator is an individual whose job is to help manage and make *easy* the process of information exchange. Although the role of subject matter experts (SMEs) is to offer advice (particularly about the content of a discussion), the facilitator's role is to help with the *how* of the discussion that is proceeding. In other words, the facilitator's responsibility is to address the journey, rather than the destination.

These definitions address group effectiveness but not *efficiency*, which is the amount of resources that a process consumes. As pertaining to group meetings, the resources are most usually *time* and the *number of staff* involved. The less efficient the team, the more time and people they need to accomplish their assigned tasks. This situation would be most ironic for a Lean management implementation, and delays are rarely tolerated by senior management who wants most projects to be completed retroactively. One of our past *bosses* used to ask why Six Sigma projects always seemed to last 6 months. Our response usually mentioned the project *scope* and the infrequency of team meetings, but team inefficiency was also a factor.

Facilitators can be *neutral* group leaders who are brought into an organization to guide projects, or they can be the organization's own skilled staff who lead or support teams. A typical example of the former would be an outside *consultant* facilitator who is contracted to conduct a strategic planning retreat for senior management. This enables the leaders to fully participate without needing to focus on the *process* of how the retreat is progressing. Basically, they just show up, give input, and make decisions. The facilitator moves the agenda, maintains the time schedule, ensures that everyone has a chance to participate, and so on. The latter situation involving an internal facilitator can be a little more difficult (but manageable) because that person must often *wear separate hats*. Specifically, they guide the meetings without expressing project-related ideas or they can temporarily *remove the facilitator hat* and give input like the other team members. Other team members will accept appropriate process comments from the facilitator but become confused or annoyed when that person makes suggestions like the regular team members or SMEs. It is of course essential that facilitators know which role they are playing, or confusion can result. Ideally, teams have separate leaders and facilitators, but this is not the typical scenario. Few organizations have dedicated staff facilitators, and those that do often eliminate those positions during *downsizing*. The leader/facilitator has become the most common approach.

When Facilitation Is Appropriate

A facilitation approach is appropriate when the organization is concerned with both the decision that is made and the way that the decision is made. For example, an organization may be moving away from the military command-and-control (autocratic) style of management to a participatory one. To encourage staff to embrace more involvement, the manager may choose to act as a facilitator rather than an expert or the final arbiter for the decision. In this type of situation, longer term process goals become as important as making a good decision.

As another example, let us envision a government employee whose task is to communicate with the members of public/interest groups regarding legislation and regulation. As one purpose of this communication is to reduce resistance to legislation and regulations, the employee can choose a more facilitative, consultative role rather than being a simple *bearer of information*. In this case, the facilitation role is more likely to encourage others to be more cooperative.

OVERVIEW OF COMPETENCIES AND CHARACTERISTICS

If you are involved in any type of facilitation (whatever you may call it), you might want to consider the competencies and characteristics of an effective facilitator as outlined by the Harrington Institute.

The facilitator competencies usually follow the following guidelines:

- Distinguishes process from content
- Manages the client relationship and prepares thoroughly
- Uses time and space intentionally
- Is skilled in evoking participation and creativity
- Practiced in honoring the group and affirming its wisdom
- Capable of maintaining objectivity
- Skilled in reading the underlying dynamics of the group
- Releases blocks to the process
- Adapts to the changing situation
- Assumes (or shares) responsibility for the group journey
- Demonstrates professionalism, self-confidence, and authenticity
- Maintains personal integrity

The facilitator usually commits to a style of

- Asking rather than telling
- Paying personal compliments
- Willing to spend time in building relationships rather than always being task oriented
- Initiating conversations rather than waiting for someone else to do so
- Asking for others' opinions rather than always offering their own
- Negotiating rather than dictating decision making
- Listening without interrupting
- Emoting but able to be restrained when the situation requires it
- Drawing energy from outside themselves rather than from within
- Basing decisions on intuitions rather than having to have facts
- Has sufficient self-confidence that they can look someone in the eye when talking to them
- More persuasive than sequential
- More enthusiastic than systematic
- More outgoing than serious
- More like a counselor than a sergeant
- More like a coach than a scientist
- Is naturally curious about people, things, and life in general
- Can keep the big picture in mind while working on the nitty-gritty

If you have a natural task-oriented leadership style, you may find it difficult to be thrust into a situation where facilitating is a more desired approach, as it is not always easy to give up the expert's leadership position in a group. However, you may find it useful to examine your involvement in group activities, whether as a formal leader or a group member, and determine if you can translate the aforementioned characteristics and competencies into changes in your behavior that will allow you to contribute more effectively to the group, and to achieve your organization's goals.

WHERE DO YOU STAND AS A FACILITATOR?

Before discussing more about the specific details of facilitation, it is important to engage in some self-reflection. The facilitation assessment that follows is designed to provoke thought. We want you to honestly answer the

30 items in Table 15.1 by placing an "x" in the appropriate column from "Most of the Time" to "Almost Never." We do not provide a scoring key but strongly suggest that you think about your responses. Do you see any patterns? How do you feel about some of your answers? Do you need to change some of your current behaviors? Do you engage in certain *avoidance* or *defensive* behaviors to compensate for your current attitudes? If you are a manager or supervisor, how might your staff rate you as a facilitator. Take a risk and ask them to anonymously fill out the questionnaire. Then discuss the results with them. That somewhat *scary* decision could start your improvement journey if you listen to their feedback, accept what has value, and take steps to improve. By doing so, you will also model personal change behavior for your staff. The rest of this section provides more information to facilitate your new adventure, and the payoff could be huge. All will benefit.

TABLE 15.1

Facilitation Assessment

Items When Facilitating, Do (Are) You	Most of the Time	Frequently	Occasionally	Almost Never
1. Demonstrate professionalism, self-confidence, and authority?				
2. Believe that people are more *invested* in their own ideas?				
3. Trust and respect the group's *wisdom*?				
4. Create and maintain a safe group environment?				
5. Work to address what is important to my customers?				
6. Focus on the meeting/group process and not just content?				
7. Sensitive to the *energy* level in the group?				

(*Continued*)

TABLE 15.1 (*Continued*)

Facilitation Assessment

Items When Facilitating, Do (Are) You	Most of the Time	Frequently	Occasionally	Almost Never
8. Work to increase participation and creativity?				
9. Use time and space strategically?				
10. Work to organize information, find patterns, and make connections?				
11. Encourage input from divergent points of view to hear all sides?				
12. Maintain objectivity?				
13. Pick your battles when there are differences or conflict?				
14. Comfortably cut off long-winded, unproductive comments/discussions?				
15. Maintain personal integrity?				
16. Prefer to ask questions than give answers?				
17. Goal oriented and seek *closure*?				
18. Flexible enough to make changes when necessary?				
19. Work to prevent *scope creep*?				
20. Listen to the whole message—what is the talker saying verbally and nonverbally?				
21. Check for understanding and accuracy?				

TABLE 15.1 (*Continued*)

Facilitation Assessment

Items When Facilitating, Do (Are) You	Most of the Time	Frequently	Occasionally	Almost Never
22. Use active listening techniques when appropriate?				
23. Be open to feedback even when it is negative?				
24. Praise and give positive feedback?				
25. Focus on both tasks and relationships?				
26. Share responsibility for the group's journey?				
27. Attempt to simplify and make the process easier?				
28. Know which words and phrases you respond to emotionally?				
29. Restate and/or summarize discussions to increase understanding?				
30. Actively pursue continuous improvement?				

WHAT SPECIFICALLY COMPRISES THE PROCESS OF FACILITATION?

A leader/facilitator should be able to employ the following twelve skill sets to aid a lean management implementation.

1. Communications.
2. Understand group dynamics and development.

3. Simplify the complex.
4. Plan for, structure, and control meetings and Lean events.
5. Provide a safe learning and working environment.
6. Help people see and understand.
7. Help people gather and analyze information to drive operational improvements.
8. Help people make decisions.
9. Eliminating non-value-added activities.
10. Focus on process.
11. Achieve pull and flow.
12. Strive for zero defects.

Communications

The most important skill for facilitators is *communication* because it is the vehicle for all of the other skill sets that follow. Unfortunately, it is too often assumed that leaders/facilitators possess these skills. In reality, only the very good ones communicate well. Specific tools and aspects of this include

1. Icebreakers
2. Humor
3. Encouragement and praise
4. Listening
5. Questioning
6. Checking
7. Giving feedback
8. Nonverbal communication
9. Speaking
10. Writing

Icebreakers

We begin with the logical first step: icebreakers. Whether it is a workshop or a project team, trainers/leaders/facilitators often use some technique to help people get to know each other. Minimally, this includes simple introductions. If some other activity is employed, it should be short and should *make a point*. Do not be too *cute* and try not to embarrass people.

Remember: not everyone (especially men) likes the games played in *baby showers*.

Humor

Humor is a powerful tool if it is used wisely. It can help make difficult meetings *bearable*, or it can upset people and cause serious problems. The right amount adds value, but too much gets in the way of business. The best humor is spontaneous and directed at yourself. You must be culturally sensitive and avoid gender, age, religion, physical and other challenges (including height and weight), and politics. Avoid long jokes because they take time and many people forget the punch line. Remember: sarcasm is bad because it is really disguised anger; wit is better, but it can be too clever or obscure; and good humor is best because everyone enjoys it. Finally, humor can be acquired even if you do not possess a natural sense of humor. Even successful comedians collect jokes and practice the delivery of new material.

Encouragement and Praise

Encouragement and praise are the best tools for promoting positive behavior. Psychologists have long known that reinforcement strengthens behavior, especially if the reinforcement is positive. Encouragement and praise help promote a *safe* team environment. It increases member participation and ultimately satisfaction.

Listening

Listening is the most important part of communication. Good listeners become successful managers and valued friends. Listening is much more powerful than speaking because it does not matter what you say or how you say it "if I close my ears." It begins when people stop talking, and there is a popular saying that "people have two ears and one mouth and they should be used proportionately." Listening is an active, learned skill that requires serious training. It is a formal part of the curricula for mental health professionals and salespeople, and it should receive more emphasis in medicine. Most others have had courses in writing and maybe speech but rarely listening. An interesting online article (www.artofmanliness.

Type of Communication	Percentage of Time Spent Communicating	Time Spent Learning
Writing	9	12+ years
Reading	16	6–8 years
Speaking	30	1 year
Listening	45	<6 months formal training

com/2012/05/02/how-to-listen-effectively) suggests that most adults conform to the following:

It is sadly ironic that the most frequently used communication skill is mostly learned through informal instruction and experience. Listening is not just *hearing*. According to Webster's online dictionary (http://www.merriam-webster.com/), listening means "to pay attention to sound …" or "to hear something with thoughtful attention." This implies different levels of listening practice, and Burley-Allen (1995, p.14)[4] suggests three levels:

Level one: Empathetic listeners suspend judgment and place themselves in the other person's position. This demands acknowledging that person and listening at both the verbal and the nonverbal levels. Full concentration and energy are required.

Level two: These people hear words but do not really listen. They remain on the surface and do not really understand. They tend to be *more logical than emotional*, and this can lead to misunderstandings.

Level three: They *listen in spurts*. Concentration is limited, and the listening is passive. These people prefer *talking*, often become distracted, and tend to rehearse their responses when they should be listening.

Good listening is hard work, and competent therapists are very tired after a full day of patient sessions. Active listening is the most powerful form of this *sense*, and it requires practice and dedication to ensure that you truly *hear* the other person and they know that you are listening. Active listeners lead with such phrases as *It sounds like (as if)* … , *You seem* … , *It appears to me that* … , or *If I understand you, then* … . They vary the use of these expressions so that they do not get too repetitive and mechanical, and they wait for the person's acknowledgment that they did hear what was said.

Questioning

Questioning is essential for understanding and good data collection. There is an effective tool known as 5W2H that helps us remember the areas we should question, such as what, when, where, who, why, how, and how many/much. Avoid *why* if you do not want to get complicated and often psychological responses. Journalists use this technique to structure articles, and it can be the basis for good data stratification. Good questioning ensures that teams have enough of the right kind of information to make the right decisions.

Checking

Checking is a very effective process tool that can be used to obtain clarification, for accuracy, and for summarizing. It can also help us identify another person's feelings, but go there cautiously. This is not meant to be therapy. Checking is as simple as saying, "I would like to check with the group? Does everyone understand the last statement?" Process checks are invaluable tools, and all members should feel empowered to use them. The art is knowing when to use them.

Giving Feedback

Feedback is essential for learning and effective work. Good work design incorporates feedback so that workers know when they are *doing it right*. This can include visual controls, which are a key element in Lean production. If the work does not automatically provide feedback, then supervisors or coworkers must step in. This can be done with positive, neutral, or negative feedback. We already talked about praise or positive feedback. This form can be incredibly powerful if it is not overdone or insincere. The challenge is to know when to use it. Negative reinforcement can be necessary, but it often produces a backlash or other negative behaviors. Neutral feedback is as simple as just commenting on the observed behavior. For example, "I just noticed that you checked the temperature gauge." There is no opinion here, just a neutral observation that enables the worker or team member to increase his or her own awareness. This subtle communication can help people make the *right* behavioral choices. Be careful that your neutral observation is not coupled with positive or negative nonverbal messages. They carry more weight.

Nonverbal Communication

Nonverbal communication was called “listening with the third ear” by the famous psychiatrist Theodor Reik. It was later popularized as *body language*, and a popular expression then was “the body does not lie.” Most of the communication messages are nonverbal, but interpret these messages very carefully because they can be strongly influenced by cultural and gender differences, and so on. Remember this when you schedule meetings: if the meeting is very important, it must be *face to face*. I need to see the person to have a chance to understand what he or she is saying. Be aware of *packing up* behaviors and energy levels. They could signal the need to end a meeting. Watch for *open* or *closed* postures when important information is being discussed. For example, are people leaning forward or back in their chairs? Are people folding their arms because they are *not buying it* or because they might be *cold*? Finally, be aware of strong feelings *behind the words* because they can be important qualifiers. Feelings provide the energy behind the action, but different people often react with different emotions. Most importantly, facilitators must be aware of their *own* nonverbal behaviors. A lack of this awareness is called a *blind spot*, and it can cause embarrassing moments and greatly reduce facilitator effectiveness. If you notice a possibly important nonverbal message, you can use *checking* to verify.

Speaking

Speaking is the most frequently used form of communication, but it is still a skill that requires training and practice. This is true if you are speaking to only one person or addressing a large group. Use the following ideas to increase your success: be courteous and polite; keep it short; speak up and enunciate; organize your thoughts; use simple vocabulary; avoid slang and swearing; use proper grammar; and avoid *um*, *ok*, *you know*, and *long pauses*.

Writing

Writing is also frequently used, and skill levels vary tremendously. Most of the aforementioned tips for speech also apply to writing. In addition, it is essential to remember that writing leaves a permanent record of the communication, so you must be careful. It is very hard to deny real written words. It is especially important to write carefully when using e-mail, texting, or Twitter if you have a temper. Cool down before you approach the keyboard.

If you must focus on one of these facilitation skill sets, the only choice is communication. It will provide the greatest return on investment.

Group Dynamics and Development

Facilitators must understand that all groups follow a natural developmental cycle originally popularized by Tuchman:

Readiness Stage	Drivers	Outcomes
Forming	Awareness	Commitment/acceptance
Storming	Conflict	Clarification/belonging
Norming	Cooperation	Involvement/support
Performing	Productivity	Achievement/satisfaction
Adjourning/reforming	Completion	Results/recognition

All groups follow the aforementioned readiness stages with the accompanying drivers and outcomes. The progression can proceed with minimal problems, or it can be reduced to a series of time-consuming conflicts and drama. This, of course, costs time and often reduces the quality of the final products. A competent facilitator embraces the inevitability of the stages and works to minimize the effort required to move through each one.

Groups begin with the Forming stage and the desire for awareness influences activities and behavior. People are assigned to this new project team and they have a lot of questions. Some typical questions may include the following: what is the assignment? What is expected of me? Who are these other people and what can they contribute? When and for how long are we going to meet? How will we operate as a team? The leader/facilitator must satisfactorily address these and other questions early for progress to be made. Introductions must be made, management's expectations for the project must be explained, team roles must be identified, and *rules of the road* must be established. The last task is often ignored, and this can lead to later problems. Experienced facilitators have their teams brainstorm ideas on how they want their team to operate. The items are written on a flip chart, and a final list is determined. Typical rules may include begin and end on time, one person talks at a time, and there are no bad ideas. Facilitators (and team members) will often refer back to these rules if things get off track. The final outcome of this stage is commitment/acceptance of the task and team members, and so on.

Unfortunately, the Forming phase does not readily lead to established, positive group behaviors. Some team members inadvertently exhibit the wrong behaviors because they have not been completely internalized. Others may test limits because they might not agree with the decisions that were made. These behaviors take up the limited time and usually distract

the group from the *real work*. Storming issues require a skilled facilitator because the incidents must be addressed in a win/win fashion. The facilitator in the Storming phase is like a swimmer caught in an *undertow*. The strong current will take you with it despite your struggles to resist it. The only hope is to *go with* the current (or flow) and gradually veer off to safety. A *storming* team is very similar and the facilitator must find a way to subtly change course. Conflict is the driver and successful resolution leads to clarification/belonging. The team has struggled together, and they are *stronger* for the effort.

The Norming stage is based on the desire for cooperation. Time and energy have been spent in conflict and the team does not want that to continue. There are internal and external pressures to *get things done*. This occurs when the team realizes what behaviors work best and which should be abandoned. The positive choices become *standardized*, *established practice*. The facilitator helps the team identify and accept these positive routines, and this results in increased involvement/support.

Performing is the phase in which the team makes real task-related progress. Driven by the desire for productivity, team members have learned *what works* and they now reach for success. A competent facilitator/leader backs off the controls and allows them to press on. The team knows what to do and how to do it. This of course leads to achievement/satisfaction.

The final stage is Adjourning/reforming, which is driven by strong needs for completion or closure. Team members want to succeed and get back to their regular job or the next project. In fact, staff members temporarily *loaned* to projects are often formally *released* back to their regular duties. Project efforts should lead to some verified results and formal recognition. Most people value genuine praise from managers they respect. Do not forget the *attaboys*. Too many organizations ignore this important final step.

Simplify the Complex

Remember that Webster's antonym for facilitate is complicate. This is obviously facilitation *gone bad*. Too many theories and management models are hopelessly complex. To become popular, they must be understood or proved valid. Facilitators must be able to help team members *understand*. The classic example from Lao Tzu (and later popularized by Mao Tse Tung) is as follows: "The journey of a thousand miles begins with the first step." A large, ambitious task can be overwhelming unless it is broken down into smaller parts. Systems theory teaches us that there are levels,

relationships, and boundaries. In quality improvement mapping, we can look at an organization as a group of related processes and represent this as an enterprise or value stream map. We can work down to an individual process and create a macro-level map called a SIPOC (Suppliers, Inputs, Process, Outputs, and Customers) or a mid-level map known as a flow chart or swimlane.

It is a challenging task to understand a *whole* organization, but individual workers can easily learn the tasks in one process step. Facilitators know how to *break down* the complex and make it simple. They encourage the use of simple vocabulary and discourage the use of jargon and acronyms when all team members are not SMEs. A sure sign of expertise is the ability to simply explain complex subjects to the newly exposed. How many times have you taken a difficult class (e.g., statistics) and had teachers that could only offer one explanation? Facilitators encourage the creation of cross-functional teams, and they want team members to collectively possess the needed knowledge, skills, and attitudes. They check for understanding and make time for explanations.

Plan for, Structure, and Control Meetings and Lean Events

Most meetings without a plan are doomed to failure. They can still be relatively successful; however, that would probably be due to the nature of the team or task. More than likely, it was simple *luck*. Poorly planned meetings are not productive, and poorly designed Kaizen events are usually disappointing. Planning includes the following:

1. Knowledge of organizational goals, objectives, strategies, and so on
2. Project charters
3. Team selection
4. Stakeholder analysis
5. Team roles
6. Ground rules
7. Action plans
8. Meeting agendas
9. Minutes
10. Checklists
11. Room arrangements
12. Use of time
13. Dealing with challenging people

This section contains some tools that are not modified from their traditional formats. Updated or simplified tools (e.g., charters) will be presented in more detail in Chapter 16, Facilitating Lean Management Systems.

How can you have an effective Lean management system implementation meeting if the leader/facilitator does not know how this project fits into the whole organization?

Knowledge of Organizational Goals, Objectives, Strategies, and So On

Knowledge of goals/objectives and strategies provides perspective, and this aids planning. Goals are usually general statements of purpose, whereas objectives are more specific. Objectives often contain numerical targets and completion dates. Sometimes, these brief definitions are reversed. Strategies are usually approaches or projects designed to accomplish the goals/objectives. Management should systematically communicate this information to staff, but group facilitators cannot assume that it was done effectively.

Project Charters

Project charters are simple contracts between management and the project team. They should be brief documents of one or two pages. Charters formally launch teams, and the specific details help ensure that everyone is on the same page. Have you ever been given a *vague* assignment and spent time trying to figure out what the boss wanted? This can waste time and cause anxiety, and it is hardly Lean thinking. Sometimes, you *guess right*; but too often the wrong product is produced, leading to disappointment, recriminations, and rework. Clarity and agreement can prevent those missteps. See Chapter 16, Facilitating Lean Management Systems for more details.

Team Selection

Team selection is crucial for project success. Jim Collins talks about "getting the right people on the bus … and putting them in the right seats." Make the wrong choices here and facilitation challenges increase geometrically. Getting the *right* people often involves negotiation because managers do not always want to lose their best people for some other work. The champion can help expedite these decisions. The right selection includes criteria such as skills, experience, interest, availability, and compatibility. Teams need SMEs who do the work. SMEs can be regular team members or scheduled in when needed. This can be a mix of experienced and less experienced

people. Interest and availability are somewhat related. Team leaders want motivated members, and interest lessens if a worker was planning a vacation during the project time frame. Compatibility is crucial because personality issues and conflicts drain time and energy. Team leaders/facilitators need to ask the tough questions before team membership is finalized. Finally, strong teams have diversity because it promotes creativity.

Stakeholder Analysis

Stakeholder analysis facilitates team success because it requires strategic thinking. This is a careful, structured approach to identifying the organization's key internal and external *players* or stakeholders. You must then *rate* their current level of support for the project and identify steps to increase it. This requires *political* acumen and insight because this kind of analysis can backfire in embarrassing ways if it is not done carefully. Once again, the champion is crucial, especially if some of the parties are high-level leaders. Most of the team members will not know these executives.

Team Roles

Team roles must be identified before or early in the process. Important projects need a high-level champion to advocate, obtain resources, and *run interference*. This is especially important in *politically charged*, competitive environments. Champions should be part of the senior leadership team or have access to key members. Champions often help select the team leader and prepare the charter. The team leader is responsible for running meetings, *moving* the agenda, and accomplishing the project goals. This cannot happen if the person does not know how to run a meeting. Their mission will be less challenging if the team has an experienced facilitator. This person focuses on *process* issues such as energy levels and individual participation. They can also help the team leader address conflicts, which will be discussed in the *Dealing with Challenging People* section. Team leaders usually assume both roles, but this can be very challenging. It is nice to have a person to just focus on process. There should also be a timekeeper to watch the clock and a *data* manager to handle the collection and management of all information. A scribe or recorder is important, especially if the team leader must also facilitate. This person needs to be able to print well and *capture the essence* of a discussion. Check for the accuracy of their *interpretation*. Also, if you are responsible for verbally *reporting out* the team's work ensure that you can read what the scribe has written.

Ground Rules

Ground rules or rules of the road are usually established at the first meeting. All entities need to create operating rules, and project teams are no exception. The facilitator accomplishes this with simple brainstorming, recording on a flip chart, and discussion. Common rules can be begin/end meetings on time and only one person should speak at one time. Some groups will suggest "what is said here stays here," but this can be difficult to enforce. Parking lots and "Enough, Let's Move On" (ELMO) are often mentioned, and they are discussed later in this section. Written and accepted rules can be referred to later and then be modified when necessary.

Action Plans

Action plans provide a framework or *road map*. They contain details that help the leader/facilitator know "where they are or should be" in a project and help with *tracking* progress. Action plan status updates are also logical items for meeting agendas. See Chapter 16, Facilitating Lean Management Systems

Meeting Agendas

Meeting agendas help organize and orchestrate meeting flow. They should also be sent out or posted before the meeting to help individuals prepare. PAL is a simple format for good agendas. The *P* stands for *purpose*, which is a brief statement or reason for the meeting. It also suggests what the team hopes to accomplish. The *A* is for *actions* or the items to be covered during the meeting. Always include follow-up or *old* business from the last meeting if it needs to be addressed. Finally, the *L* is the amount of time the meeting will last. Try to have more action than discussion items. Good facilitators work from the agenda, only digress when it makes sense, and end on time. They also show respect by asking permission to *stray* or run over the agreed on ending time.

Meeting Minutes

Meeting minutes are included here as a planning tool because they aid agenda preparation. Ideally, they should be sent out to team members before the meeting, and an early meeting item is usually minutes review and approval. Minutes should be brief and capture decisions and future actions. Try to summarize important points or ask permission to electronically

record everything if people need to review discussion details. This is of course a requirement in many governmental organizations. Team leaders should always review the draft minutes before they are released because content can be controversial and some words must be selected carefully. Minutes should be filed with other important project documentation.

Checklists

Busy facilitators always use checklists. Experienced pilots do not take off without completing a preflight checklist because the consequences can be fatal. Honest facilitators can also tell horror stories about being *unprepared*. Just make sure to include the right items on your list and check it early enough to gather any missing equipment or supplies, and so on. Experience tells us what to include on the list.

Room Arrangements

Room arrangements can make or break meetings or trainings. Room size, location, and comfort are important considerations. Ideally, it helps to have a permanent location where you can post items such as process maps on walls. A convenient location is ideal but often impossible. Try to avoid *call-ins* because they are often awkward and the technology often fails. The furniture should be comfortable but not so plush that sleep is facilitated. Extreme room temperatures can affect proceedings, and noise from other rooms can be distracting. Finally, extra space will be needed for *breakout* activities. Experienced facilitators always view the room before they complete the agenda.

Use of Time

Use of time is an important element of meeting management. Typically, this involves either the timing of activities or how much time is devoted to some agenda item. The first has strategic implications because it deals with the decision to take up or postpone an issue. A facilitator might *ignore* an item because it is too emotionally charged or because it is not *politically* expeditious to address it at that time. It could also be as simple as there is not enough time remaining in the allotted meeting time to do it *justice*. The second aspect of time deals with the length of meetings, which is the L in the PAL model discussed earlier in this section. Respect the agreed on amount of time and only extend the meeting if it is extremely important and the group agrees. There are two effective tools besides the agenda for

managing meeting time and increasing meeting *flow*. They are parking lots and ELMO. A parking lot is usually a flip chart that is reserved for recording important but untimely discussions and information. For example, someone might make an important (but perhaps irrelevant) comment, but it needs to be ideally discussed at another time. Ask their permission to write it on the flip chart, and decide when it will be discussed. This can often satisfy a team member who wants to be heard, but doing so would impede progress at that time. Then be sure to revisit it at a later time, or your credibility will be affected. If the item is potentially *sensitive*, this might enable the leader/facilitator to handle it *off-line*. Teams can make ELMO tool as part of their operating rules, and any member can use it when things *bog down* and the agenda must be moved. Unfortunately, some groups use it too often and the facilitator might have to intervene and allow a discussion to continue.

Dealing with Challenging People

Dealing with challenging team members can be a challenge. This is why we discussed the importance of selecting the right mix of people before the first team meeting is held. Challenging behaviors usually involve excesses or too much of a good thing. Team leaders/facilitators want verbal people but not those who dominate discussions. Quiet, reflective people often come up with valuable insights, but they need to say *something*. Disagreement is good, but hostile conflicts are counterproductive. Experts provide valuable information, but they can also become unpopular *show-offs*. Humor adds value, but class clowns waste time. Agreeable people contribute to a *peaceful* environment, but sometimes disagreements are needed. *Tiger play* can help maintain high group energy levels, but when it is excessive people can get hurt. Some people are *Negative Nellies*, and others are *Wanderers*. It takes real skill to facilitate around these behaviors, and special seminars are available to help learn them.

Provide a Safe Learning and Working Environment

Successful project teams take risks and *try new things*. This requires a safe environment that begins with the leader/facilitator. People want to be understood, so facilitators check for understanding. They also exhibit appropriate empathy at the right times. If you think that a comment came from a *special* place, ask the person to share some of the background. Encourage *out-of-box* thinking and risk taking. Remember Edison's idea about *failing forward* and ruling out possibilities. When the team brainstorms, hold off criticism until all ideas have been proposed. Thank people

for their suggestions, and try to criticize ideas and not people. If the leader/facilitator makes a mistake or says something *stupid*, he or she should model mature behavior and *own* up to the mistake. Better yet, laugh at yourself. Humor helps people feel more comfortable. Use anonymity when necessary. For example, anonymous surveys can help and brainwriting can be a safer alternative than brainstorming. The former involves writing suggestions on cards, and the latter uses verbal ideas. Also, keep office politics out of the meetings and remember that office behaviors are often influenced by the organizational culture. Respect the culture because it is more powerful than any facilitator. Finally, intervene with inappropriate behaviors when the group cannot effectively *deal* with them.

The *safety* of the environment also has significant impact on the reliability and validity of organizational data. If there is a lot of pressure to succeed and workers are evaluated on meeting numerical targets, there is a possibility that some workers will *fudge* the data. There have been major scandals in law enforcement over *cleared* crime statistics and in education regarding student test scores. Data should ideally be used to identify problems not *shoot messengers*. How does your organizational culture approach data?

Help People See and Understand

Listening is the most important sense during group conversations, but *seeing* is crucial for any kind of process or data analysis. I still have memories of a dissertation advisor who tried to explain some algebraic transformations over the phone. I became hopelessly lost not realizing at the time that I was a *visual learner* and that he should have been a better teacher.

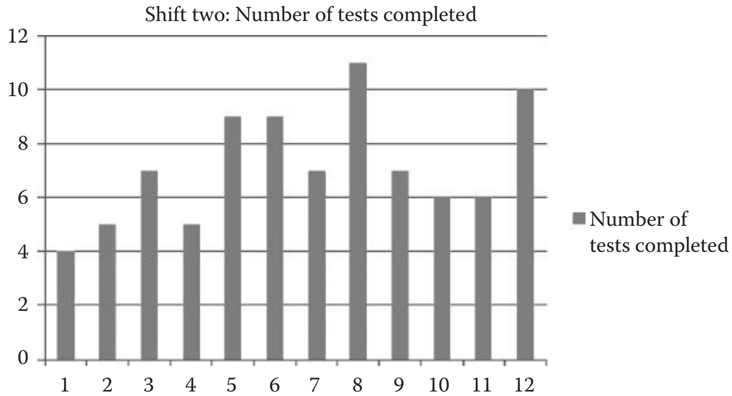
Learning to see is a central Lean concept, and tools such as 5S, visual controls, and mapping facilitate this. The 5S approach begins with reducing clutter, cleaning (shining), setting things in order, standardizing best practices, and sustaining improvements. It is easier to see important things when they are put in the right places and nonessentials have been removed. Visual controls are discussed in Chapter 16, Facilitating Lean Management Systems.

Learning to see and understand also involves the following areas:

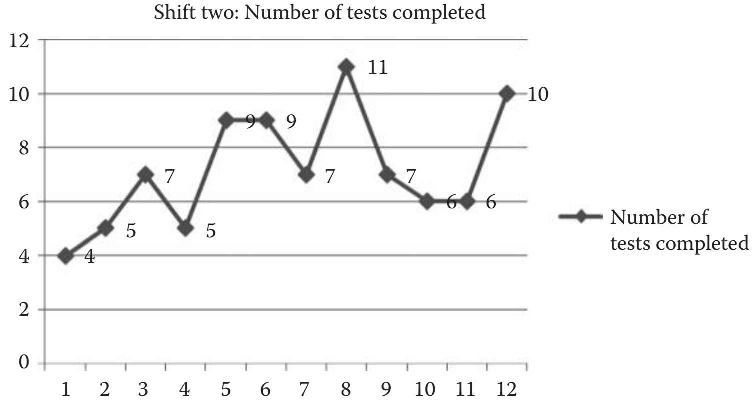
1. Focused attention
2. Keeping it simple
3. Using color wisely
4. Using the right charts, titles, and labels

Focused Attention

Focused attention is the ability to get your team members to look at the same or most important things. A common technique is the use of a flip chart during a meeting. If verbalized brainstorming ideas are written on a flip chart, then *all eyes* will more likely be focused on each item as it appears on the list. This would prompt participants to *bounce off* a previous idea and generate new thoughts. This would be much harder if the scribe just wrote those ideas on a pad in front of them on a table. What happens then? Group members must try to look at what the scribe is writing or remember what was said. How efficient/effective will that information processing be? Another example of this is shown in the following graph:



This is a simple bar graph of some *Shift Two* trend data. Where do you want the viewers to look: along the length of the bars or at the tops? Notice the difference if a line graph is used:



Now the viewer's eyes tend to naturally focus on the triangle markers and the numbers next to them. This is also a question of selecting the right chart for a particular purpose. You are helping people see without having to search for the important information. Just look at the graphs and understand the communication concept. It is not the intent of this section to teach you how to construct the graphs.

Keep It Simple

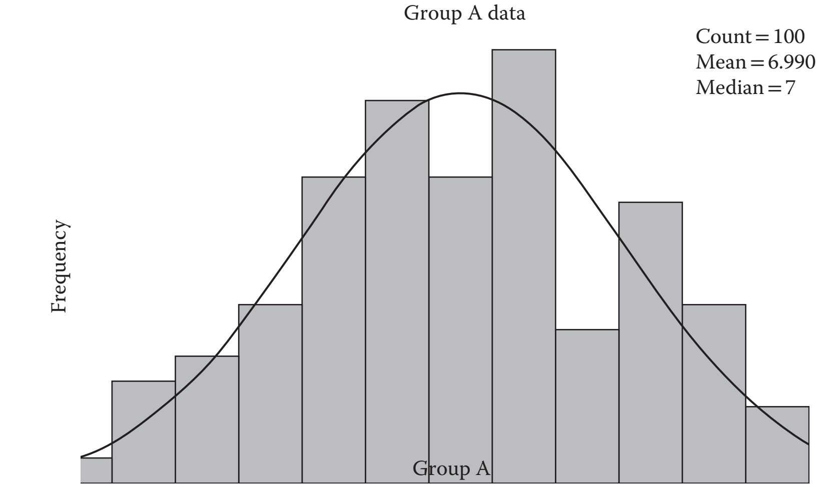
A "picture is truly worth a thousand words." Let us try a simple experiment. What do you see in the following figure?

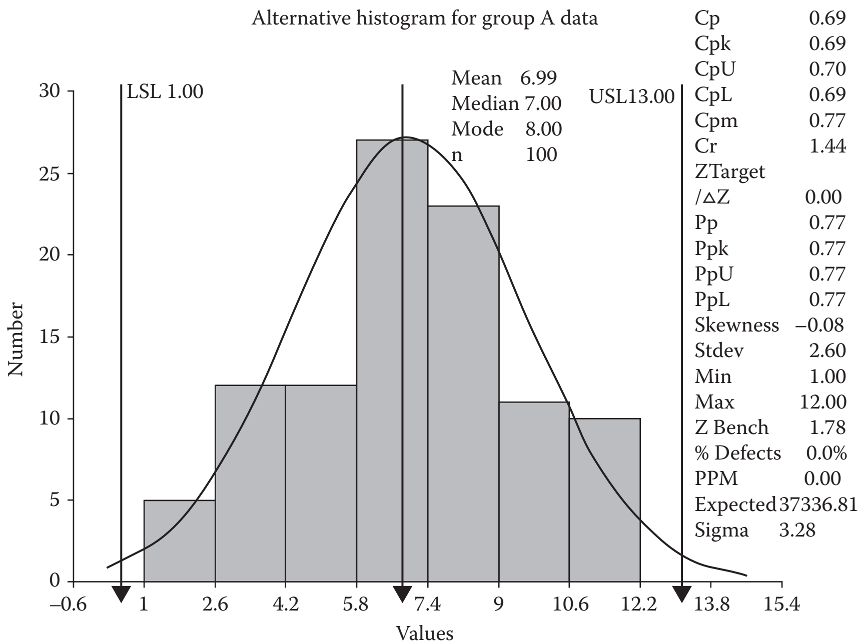
1	11	3	4	5	6	10	9	6
12	8	6	5	8	7	4	9	10
5	8	4	7	10	8	8	3	3
4	5	6	5	11	2	8	4	8
7	2	5	9	11	10	7	8	
8	8	6	9	5	2	6	6	
7	6	9	7	10	4	7	8	
6	10	5	11	11	10	5	8	
5	8	10	7	11	7	10	7	
8	7	6	6	6	11	5	9	
6	8	5	6	12	8	4	3	
3	6	8	10	2	7	12	10	

The most appropriate response might be "a bunch of numbers arranged in a table." Additional insights would require organizing, counting, and questioning. Now reflect on the power of a simple graph, a histogram:

Now, some team member (with a statistics background) might suggest that "there are 100 data points from group A; the mean or average is 6.99; the median is 7; and it looks like the data is almost normally distributed." One picture can tell us a lot about some otherwise *unintelligible* information.

Now, look at a histogram for the same data set that was created with another statistics program. By default, it includes a lot more information. What do you want the viewers to look at? Do you need all of that generated data? Are you prepared to answer questions about some potentially

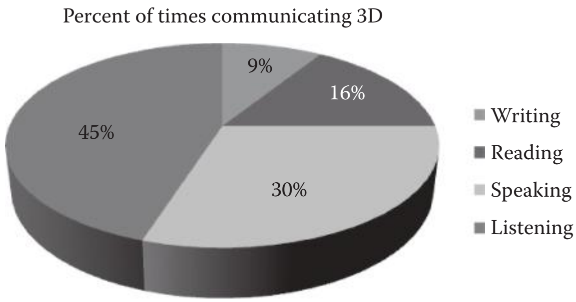




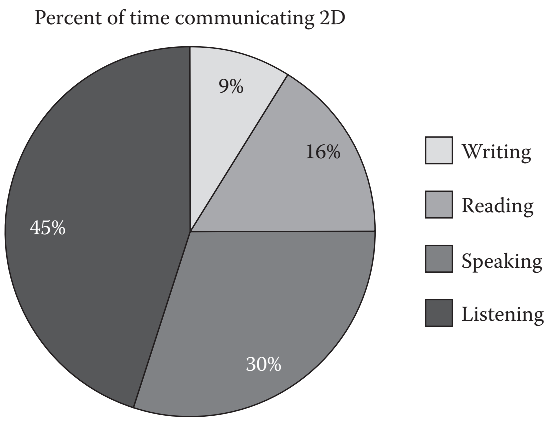
irrelevant statistics? Limit the information on charts to what is essential. Keep it simple.

Process maps can also get too complex and defeat their primary purpose of helping us see and understand. Value stream maps can show a lot of information, but there can be too many symbols, arrows, and measures. Swimlane maps can contain too many steps and get too long, which means the developers got too *micro*. Save the detail for task lists.

Complexity can also be introduced when you produce three-dimensional (3D) charts instead of simpler two-dimensional versions. Note the differences in the following figures. Do people really need to look at the large 3D edge? This problem can be even greater with 3D bar graphs.



There is no doubt which version is simpler. This effect can be even more pronounced with bar graphs, especially stacked bar graphs. The third dimension can cause distortions that make the reference lines hard to judge, and some bars in the *back* can be hidden.



Complexity can also be a challenge with PowerPoint presentations. All too often, presenters crowd too many words and graphics on too many slides. This situation is further exacerbated when the font sizes are too small and the presenter insists on reading the slides. Keep it simple and just use short bullet points as an outline of *reminders*. Finally, do you use the *phase in* and *sound* features? Should you risk a technical mishap? How many senses do you have to apply? What do you want the viewers to remember?

Using Color Wisely

Use color wisely when designing presentations and creating visual controls. This is not the time to be dramatic and overly creative. Do you want viewers to remember the design or the content or the direction/speed? Also, people have very subjective responses to color and some are even color blind. What do your *customers* like? Professional designers understand and use color wheels to aid color selection (see Figure 15.1).

Designers know about *harmony* and the pleasing nature of using *adjacent* colors or shades of the same color. It is also safe to use colors that appear in *nature*. They further understand that opposite colors can be used if you want *contrast*, and they also realize that color is *expensive* if that is a consideration. More and more companies are limiting the use of color copiers. Finally, color can have inherent symbolism. Traffic light colors have universal meaning, so use them logically and consistently. If *red* is negative on one slide, do not use it with positive results later in the presentation. Finally, you can alternate rows of color or shading to make long spreadsheets less boring and easier to read. Some facilitators even alternate different colored markers when they right on flip charts.

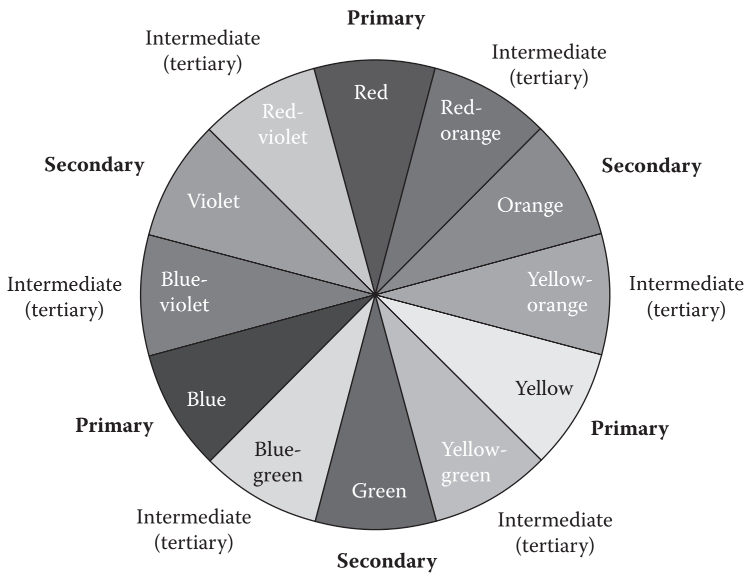


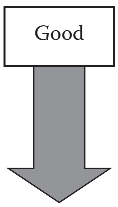
FIGURE 15.1
The color wheel. (From http://cdn.pelfusion.com/media/wp-content/uploads/2011/05/color-wheel-main2.gif.)

Use the Right Charts, Titles, and Labels

Charts and graphs have specific, recognized uses. For example, line graphs are best used to show data trends, whereas bar graphs can show *amounts* of data at one point in time. Pie charts are preferred when you want to show the *parts of a whole*. Titles should briefly set the necessary context. Good titles address the what, when, and where of a situation. Viewers should not have to ask those questions when they are looking at a graph. Also, be careful to clearly label the parts of a chart or the axes of a graph. It can also be helpful to add a data box.

Prepared by John Smith on 12/12/12
from ABC Enterprise data.

This simply addresses the question of who created this chart and where they got that data. Sometimes, *directionality* can be confusing. Note how the following simple graphic element on a chart answers this question.



Help People Gather and Analyze Information to Drive Operational Improvements

Lean management systems incorporate performance measures in their information architecture. Dr. Deming had a sign outside his office that warned "In God we trust; all others bring data."

Collect *bad* data and you will make bad decisions. Also, nothing slows down projects more than data collection. If you want to see people moan or suddenly get *real busy*, tell them you need to conduct a survey. Data collection takes time and resources, so approach this challenge cautiously. The following guidelines can help:

1. Only collect the right *important* data.
2. Be concerned about reliability and validity.
3. Get help.

Collect Only the Right Important Data

Because it takes resources to collect data, make sure the data are important and you use them. Data should relate to key processes and include essential in-process and end-process measures. These data can also be referred to as inputs and outputs or *X*s and *Y*s. This is important because we analyze the *X*s to understand the *Y*s. Unfortunately, organizations collect mostly *Y* data, so improvement efforts are hampered. Second, collect continuous or variable data because they are more precise and you do not need as much to use the more powerful statistical tests. On the other hand, attribute or discrete data can only be counted, not measured. A recent hospital example illustrates this point. The administration decided that one way to mitigate a serious emergency department *hold* problem was to discharge patients from in-patient unit beds by noon. Their bed management committee tracked the number of *yes* and *no* results. This, of course, did not enable them to see how many discharges were *close* to the noon target or *far* from it.

Progressive organizations collect the right data and organize them in company-wide balanced scorecards. The data are aggregated at the highest level and can be disaggregated or *drilled down* to the smallest unit or individual worker.

Data collection can be facilitated if some of the following questions are asked during the planning phase:

What:
- What problems are you addressing?
- What questions do you need to answer?
- What data are you going to collect to answer these questions?
- What input, process, and output measures do you need to address these questions?
- What are the operational definitions of those measures?
- What are your customer's requirements?
- What type of data are they (discrete or continuous)?

Why:
- Why are you addressing these problem questions?
- Why do you need these data?

When:
- What is the specific time period for the existing data?
- What days, times, and so on will represent the new data collection period?

When do you need the data?
When will you begin and end the specific steps in the data collection plan?

Where:
Where will you collect the data from?
Where will you obtain existing data from?

Who:
Who are the subjects in the study or improvement project?
Who will get the existing data?
Who will gather the new data?
Who will train the data collectors?
Who will develop the data collection instruments?
Who will analyze the data?

How:
How will you collect the data?
How will you analyze the data?
How will you sample the data?
How good is your data?
How will you report the results?
How have process changes (if any) impacted the collection of new data?
How many/much:
How much data do you need?
How many subjects do you need to survey?
How many files, reports, and so on do you need to review?
How much will this cost?

Be Concerned about Reliability and Validity

Reliability and validity are important. Carefully define the data you are collecting or you might unintentionally get very heterogeneous results. You wanted to count golden delicious apples, but you got a fruit salad instead. Dr. Deming developed a three-part model for operational definitions that included criteria, a method, and a test. Note the specificity of the following example:

Have you ever served on an interview committee in which the members rated the same interviewees very differently? If the raters were not biased, then the questions were probably not precisely defined.

If a good leader/facilitator questions the reliability and validity of the data that are collected, they might suggest a qualitative measurement system analysis. This is accomplished by considering the following 6Ms

Measure	Criteria (Definitions or Standards against Which to Measure Results)	Test (Procedure for Measuring the Criteria)	Decision (How to Determine Whether the Test Results Meet the Outcome)
Ex. 1. Writing is legible	1. The words and letters are formed correctly 2. The letters are large enough to see 3. The letters are dark enough to see	A review of statistically adequate samples that effectively and accurately measure the writing in the documents	The answer is yes to each of the three tests
Ex. 2. The investigation was completed in time	The investigation was completed in 45 days from when the referral is received from the hotline to when the case is officially closed	The referral date and time is logged into the computer when the referral is received and when the case is officially closed	The answer is yes if the time to official closing is 45 calendar days or less

The 6Ms

Areas	Examples
Machines	Are the computer programs user friendly? Are the data systems dependable?
Materials	Are the survey forms easy to read? Do the surveyors speak foreign languages?
Methods	Will data collection and analysis be automated or done by hand? What sampling procedures will be applied? How much data do you need? Are you using professionally developed survey instruments?
Manpower (people)	What are the qualifications and motivation of the data collectors? How were they trained?
Measurements	Are you collecting variable or attribute data? Are the measures operationally defined? Are they survey data?
Mother nature (internal and external environments)	Is the public reluctant to answer the survey because they have been recently bombarded with a lot of political surveys? Has a very positive or negative event just occurred ?

FIGURE 15.2
The 6 Ms of Lean Six Sigma management.

(see Figure 15.2), which were originally used in Kaoru Ishikawa's fishbone analysis. Consider the following possibilities:

Other items can be added, but the direction of this questioning should be obvious.

Get Help

Get help; data collection and analysis is serious work. Consult a competent statistician to develop sampling plans and conduct complicated statistical analyses. Most professionals can conduct basic descriptive and inferential analyses, but multivariate studies such as regression and design of experiments are usually far too complicated.

If you are going to make data-driven decisions, you must begin with the right amount of *good* data and then analyze them correctly. Finally, if an organization expends resources to collect data, it should use the data. Try to motivate cynical workers to collect new data when they know management does not look at (or make good use of) the data it already stores in paper files or computer systems. It can be a tough sell.

Help People Make Decisions

Every implementation or improvement team makes decisions that begin with the collection of good data. Different views and opinions must then be considered before the team makes and presents its recommendations. This section includes the following:

1. Collaboration and consensus
2. Force field analysis
3. Multivoting and other techniques

Collaboration and Consensus

Most people want to win; they are selfish and do not share well. Successful collaborators are both happy and unhappy with the results. Collaboration is both a win/win and a lose/lose. We see this in politics when two party *bases* complain and only the more pragmatic moderates are satisfied. Leaders/facilitators shape discussions and decisions to craft *balanced* outcomes.

Consensus is an ideal. It exists when all participants agree to some decision. Unfortunately, this is a rare occurrence, so the more realistic and accepted version is a decision that most agree on and the rest can live with and support the outcome.

Force Field Analysis

Basically, it is a technique for examining both sides of a problem or solution. These are the pros and cons or the drivers and restrainers. Engaging in this exercise ultimately improves decision making. Note the following example:

Force field analysis example

Driving force ratings (1 2 3 4 5)		Restraining force ratings (5 4 3 2 1)
Management's desire to improve	To have consistent, quality case reviews.	Management's commitment to standardizing
Push for COA standards		Case overloads
Need for operational restructuring		Other competing issues and interruptions
Need to reduce number of children in OHC		Lack of training

A simple table of information can help a team see and consider multiple, possibly competing, factors. It would be much easier to manage this type of conversation.

Multivoting and Other Techniques

Basically, the leader counts the number of items and divides by three. This determines the number of votes each participant gets. The leader passes out that number of sticky dots to each person, has them make their selections, and then places the dots next to the items on the list. If the list is on a wall or flip chart, the voting results will be easier to review. Another round of voting may be necessary if there are still too many items. Teams enjoy this energizing approach because they must get out of their seats and physically participate. The nominal group technique can also be used, but it is more complicated and potentially confusing.

Eliminating Non-Value-Added Activities

Facilitators should be oriented toward identifying and eliminating non-value-added activities in their team meetings and other Lean events. This waste or *muda* decreases the efficiency and productivity of meetings and adds more time and cost. Solutions are delayed and management becomes

dissatisfied with the team's progress. There are eight types of waste that facilitators should avoid and/or eliminate:

1. *Waiting:* Start and end meetings on time. Encourage and ensure that assignments are completed on time so that the team does not face delays with subsequent tasks. Do not spend too much time on any one topic.
2. *Defects:* Do things right the first time so that there is no rework. Make sure that the right SMEs are involved to avoid mistakes due to lack of expertise or experience.
3. *Motion:* Arrange the meeting space to reduce movement. Organize messages and documents so that team members do not have to search for the most important information. Similarly, make sure that folders and other data storage are well designed to promote efficient retrieval.
4. *Transportation:* Try to arrange meetings in a convenient location to reduce travel when attendees come from different locations. Use technology and have *virtual* meetings when the topics do not require hands-on activity. Be careful here, though, because online meetings tend to eliminate important nonverbal communications.
5. *Overproduction:* Do not produce more copies, reports, and other kinds of work than you have to. Try to go paperless if people are comfortable using available electronic devices.
6. *Overprocessing:* Do not embellish presentations more than necessary. Focus on simple, short reports that focus more on content than form. It costs money to produce *pretty* presentations.
7. *Inventory:* Limit the records you keep to the truly essential. Do you have a realistic version control system? Does everyone have to store copies on their personal computers or in their file cabinets?
8. *Underutilization of people:* Are you engaging all team members in meaningful ways? Do you miss valuable contributions when people remain quiet? Can people do other important tasks that do not fall within their job descriptions? Do they apply new knowledge and skills that were just learned in expensive trainings?

Focus on Process

Process work involves more than creating value stream and other maps. Every activity, whether work or play, occurs in the context of a process.

Good facilitators are logical sequential thinkers and doers. They understand that group processes have steps and ordered activities. They also appreciate the reality that some of the most creative solutions require abstract, random activities. Their more ordered reality includes the understanding that there is an important place for the nonlogical.

Achieving Pull and Flow

Good facilitators understand timing, pull, and flow. They intuitively sense when a meeting flows naturally according to the agenda, but they can also change direction when needed. They know that team energy levels are tied to flow because people are more engaged when there is meaningful activity and progress. They identify and remove barriers because they are like rocks in a stream. Finally, they pull the group along at the right times and strive to prevent outside *pushes* and distractions.

Strive for Zero Defects

Facilitators reach for perfection even when it might not be possible. On the other hand, they "do not let perfection be the enemy of good" as President Obama frequently said on his campaign trail. They are comfortable with the concept of continuous improvements and encourage simple Kaizens. Some background on zero defects is important.

The concept of zero defects, as explained and initiated by Philip Crosby, is a business system that aims at reducing the defects in a process and doing the process correctly the first time itself. When would a product be acceptable to a customer? It would be acceptable when it meets or conforms to the requirements of the customer—it is not just about being good. In short, when a product is built to specifications without any drawbacks it is an acceptable product. In terms of defects, a product will be acceptable when it is free of defects. When considering the concept of zero defects, one might want to know what that zero defect level is, if acceptable levels can be achieved for a product. Attaining perfect zero defects may not be possible, and there is always a chance of occurrence of some errors or defects. Achieving a level of zero defects implies reaching a level of infinity sigma, which is nearly impossible.

Consequently, the goal should be to drive toward zero defects. This can be accomplished with the knowledge that it is possible to measure nonconformance in terms of waste. By thoroughly understanding customer

requirements and developing effective waste detection and elimination measurement systems, you can effectively guide your organization toward zero defect achievement.

SUMMARY

In this chapter, we discussed the need for many components of facilitation. As we discuss, a fundamental aspect of facilitation is to make a Lean management system implementation easier to accomplish. Facilitators plan activities, guide employees, manage groups of employees, and are generally a conductor in the orchestra of the Lean transformation process.

We use the term *conductor* to describe the facilitator because like the conductor the facilitator requires a wide range of competencies and characteristics to be successful in his or her task. For example, the conductor must understand the musical script that he or she is looking at. A Lean analogy would be an understanding of the strategic and tactical plan objectives of the organization. The conductor sets the tone in the individual instruments in the orchestra through the interpretation of the musical arrangement that the orchestra is playing. Similarly, the facilitator must have an accurate high-level view of both strategic and tactical objectives in the organization. As the arrangement unfolds, the conductor must guide the orchestra through his or her interpretation of the arrangement to achieve the end result of the harmonious joining of all of the individual instruments into the pleasing sound of a symphony. The facilitation of process improvement activities parallels the conductor's in that the facilitator must understand the organization's objectives as well as all the objectives of the employees in the organization and the employees' respective process improvement skills and capabilities.

To become the accomplished facilitator (conductor) of a Lean management system implementation process, the facilitator must exhibit a range of competencies and characteristics. In this chapter, we present and discuss these competencies and characteristics. Traits like being able to adapt to a changing situation or being able to recognize some underlying group dynamics are critical for the Lean management facilitator. In a group setting, their ability to ask questions, elicit participation of the employees, and pay compliments for employee contributions to the improvement dialogue are all critical aspects of facilitation. Our facilitation assessment

allows the reader to gauge where he or she stands on the road to becoming an effective facilitator.

To achieve the conductor status as a Lean management system facilitator, we present 12 fundamental aspects of facilitation. These range from topics like effective communication to the ability to simplify the complex, helping people through the decision-making process, and ultimately focus on the identification and elimination of waste, which is critical in any Lean management system.

As we walk through these 12 fundamental facilitation requirements, we give further details on some of the three components and how to achieve them. For example, effective communication requires the facilitator to have the ability to use icebreakers, interject humor where required, encourage employee team members with praise, effectively listen to employee participation, and give feedback; most importantly, communication is the ability to use questions to guide the team toward effective solutions. All of these characteristics demonstrate both the need for and the importance of facilitation during the deployment of a Lean management system.

REFERENCES

1. Josephine Klein, *Working with Groups*, Hutchinson, London, 1961.
2. Tom L. Jackson and Karen Jones, *Implementing a Lean Management System*, Productivity Press, Portland, OR, 1996.
3. Frank Voehl, *The Integrated Quality System*, Strategy Associates, Coral Springs, FL, 1992.
4. Madelyn Burley-Allen, *Listening*: *The Forgotten Skill: A Self-Teaching Guide*, 2nd Edition, John Wiley & Sons, Hoboken, NJ, 1995.

16

Facilitating Lean Management Systems: Developing a Lean Culture and Change Management Environment

IN A NUTSHELL

Most Lean management system experts' primary message is that the adoption and use of Lean production tools and technology will most likely fail without the accompanying, successful implementation of a Lean management system based on a Lean organizational culture that engages in continuous change management.

First, in this chapter, we focus on factors pertaining to developing a Lean organizational culture. We discuss recent organizational culture change management theory and how it applies in today's organization. Our discussion will include models for managing the transition to a Lean management system model that encourages and helps people to change within your organization.

The Lean Management Organizational culture is the collective behavior of humans who are part of an organization and the meanings that the people attach to their actions. Culture includes the organization values, visions, norms, working language, systems, symbols, beliefs, and habits. It is also the pattern of such collective behaviors and assumptions that are taught to new organizational members as a way of perceiving, and even thinking and feeling. The organizational culture affects the way people and groups interact with each other, with clients, and with stakeholders. Ravasi and Schultz (2006)[1] state that organizational culture is a set of shared mental assumptions that guide interpretation and action in organizations by defining appropriate behavior for various situations.

The remainder of this chapter focuses on developing and facilitating the Lean management system. This discussion will revolve around the Lean management system model popularized by David Mann and others, the existence of multiple, connected organizational levels or the *Sweet Sixteen*, Approach, Deployment, Learning, and Integration (ADLI), and different improvement models from simple Kaizens through the DMAIC (Define, Measure, Analyze, Improve, Control).

LEAN CULTURE DEVELOPMENT

According to Schein (1992), culture is the most difficult organizational attribute to change and facilitate, outlasting organizational products, services, founders, and leadership and all other physical attributes of the organization. His organizational model illuminates culture from the standpoint of the observer, described by three cognitive levels of organizational culture. At the first and most cursory level of Schein's model is organizational attributes that can be seen, felt, and heard by the uninitiated observer—collectively known as *artifacts*. Included are the facilities; offices; furnishings; visible awards; and recognition, the way that its members dress, how each person visibly interacts with each other and with organizational outsiders, and even company slogans; mission statements; and other operational creeds.

Artifacts comprise the physical components of the organization that relay cultural meaning. Daniel Denison (1996) describes artifacts as the tangible aspects of culture shared by members of an organization. Verbal, behavioral, and physical artifacts are the surface manifestations of organizational culture. Rituals, the collective interpersonal behavior and values as demonstrated by that behavior, constitute the fabric of an organization's culture. The contents of myths, stories, and sagas reveal the history of an organization and influence how people understand what their organization values and believe. Language, stories, and myths are examples of verbal artifacts and are represented in rituals and ceremonies. Technology and art exhibited by members or an organization are examples of physical artifacts.

The next level deals with the professed culture of an organization's members–the *values*. Shared values are individuals' preferences regarding certain aspects of the organization's culture (e.g., loyalty, customer service). At this level, local and personal values are widely expressed within the organization. Basic beliefs and assumptions include individuals'

impressions about the trustworthiness and supportiveness of an organization, and are often deeply ingrained within the organization's culture. Organizational behavior at this level usually can be studied by interviewing the organization's membership and using questionnaires to gather attitudes about organizational membership.

At the third and deepest level, the organization's tacit assumptions are found. These are the elements of culture that are unseen and not cognitively identified in everyday interactions between organizational members. In addition, these are the elements of culture, which are often taboo to discuss inside the organization. Many of these unspoken rules exist without the conscious knowledge of the membership. Those with sufficient experience to understand this deepest level of organizational culture usually become acclimatized to its attributes over time, thus reinforcing the invisibility of their existence. Surveys and casual interviews with organizational members cannot draw out these attributes—rather much more in-depth means are required to first identify and then understand organizational culture at this level. Notably, culture at this level is the underlying and driving element often missed by organizational behaviorists.

Using Schein's model, understanding paradoxical organizational behaviors becomes more apparent. For instance, an organization can profess highly aesthetic and moral standards at the second level of Schein's model while simultaneously displaying curiously opposing behavior at the third and deepest level of culture. Superficially, organizational rewards can imply one organizational norm, but at the deepest level imply something completely different. This insight offers an understanding of the difficulty that organizational newcomers have in assimilating organizational culture and why it takes time to become acclimatized. It also explains why organizational change agents usually fail to achieve their goals: underlying tacit cultural norms are generally not understood before would-be change agents begin their actions.

Merely understanding culture at the deepest level may be insufficient to institute cultural change because the dynamics of interpersonal relationships (often under threatening conditions) are added to the dynamics of organizational culture while attempts are made to institute desired change.

David Mann's Lean Culture

David Mann defines culture in a work organization as "the sum of peoples' habits related to how they get their work done" (Mann, 2010, p. 3). For a group

or team members, culture for the most part is invisible and represents "the way we do things around here." It only becomes visible through displayed behaviors. In most production environments, it can be viewed in relation to the responses to the following questions about common practices:

1. What are the organization's inventory practices?
2. How often does management look at the status of production?
3. Who is involved in the process improvement activities in this area?
4. What is the typical response when a problem arises?

He arranges these thoughts (see Figure 16.1) in the following comparative table (pp. 15, 16):

Mann further suggests that organizational culture is a result of the management system, so that should be the target. In other words, change management behavior and the other behaviors that *make up* the culture and it will also change. Mann talks about the inertia of long established

Cultural Attribute	Mass Production Culture	Lean Production Culture
Inventory practices	• Managed by computer system • Ordered by forecast • Stored in warehouse areas or automated storage and retrieval facilities • Held in bulk containers • Moved by lift truck • Many hours' worth or more per delivery • Delivered by the skid or tub by forklift to vicinity of use	• Managed visually • Ordered to replenish actual use • Sored in FIFO racks or grids addressed by part number • Held in point-of-use containers • Container quantity and number of containers specified by address • Precise quantities (often less than an hour's worth) delivered to point of use • Delivered by hand cart or tugger
Production status	• Checked at the end of shift, beginning of next shift, or end of week • Checked by supervisor, higher level managers	• Checked by team leaders several times an hour • Checked by supervisors four or more times per shift • Checked by value stream managers once or twice during the shift

FIGURE 16.1
Organizational culture.

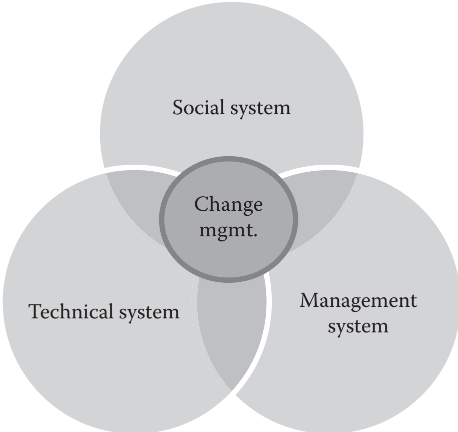
Cultural Attribute	Mass Production Culture	Lean Production Culture
		• Updated for all involved in a series of brief daily reviews of the previous day's performance
Process improvement	• Made by technical project teams • Changes must be specifically *chartered* • No changes between *official* projects	• Can be and routinely are initiated by anyone, including operators • Regular, structured vehicles encourage everyone from the floor on up to suggest improvements and perhaps get involved in implementation • Improvement goes on more or less all the time, continuously
Problem solving	• Do whatever it takes to hit today's numbers! • Work around the problem; just meet the daily/weekly production/productivity goals	• Record immediate circumstances of the miss, interruption, or breakdown • Put temporary countermeasures in place if needed to serve the customer • Assign task to identify and then eliminate causes of problem

FIGURE 16.1 (*Continued*)
Organizational culture. (From Mann, D., *Creating a Lean Culture: Tools to Sustain Lean Conversions*, Second Edition, CRC Press, Boca Raton, FL, 2010, pp. 15–16. With permission.)

behavioral practices and adds that it is naïve to think that habits can just be *broken*. He recommends that habits should be *extinguished* through change processes applied over time.

CHANGE MANAGEMENT

Change management is located at the juncture or *sweet spot* of the four systems Venn diagram below because it is absolutely essential for the successful implementation of *Lean* management and the technical systems. We discuss this dimension right after the social system, because it is such a closely related *people* variable.



The Social System focuses on the "People" part of the equation and this is the most important factor. Dysfunctional people and teams always trump the best management and technical systems. Specific topics discussed here will include leadership, organizational culture, and facilitation. The Management System represents related strategies and tactics. This includes the lean management system model (described at length earlier in the book), policy deployment (also known as Hoshin Kanri), and the DMAIC problem solving model from Lean Six Sigma. Finally, the Technical System encompasses hard and soft skills related to teams, planning, and problem solving.

Participants tend to over focus on the "tools" and that will also only take them so far. This final part of the section will demonstrate ways to facilitate the tools to make them easier to use. Change Management is at the center or "sweet spot" of this system's approach. Basically, leadership cannot assume that followers will readily embrace "new things." The theories of Lewin, Bridges, and Kotter will be briefly explained.

Managing Transitions Model*

In past years, perhaps, leaders could simply order changes. Even today, many view it as a straightforward process: establish a task force to lay out what needs to be done, when, and by whom. Then all that seems left for the organization is (what an innocent sounding euphemism!) to implement

* Adapted by Frank Voehl from the book by William Bridges called *Managing Transitions*, Da Capo Press, A Member of Perseus Books Group, Cambridge, MA, 2003. The concept first appeared in a newsletter article by William Bridges and Susan Mitchell Bridges (Leader to Leader, No. 16, Spring 2000).

the plan. Many leaders imagine that to make a change work, people needed only to follow the plan's implicit map, which shows how to get from here (where things stand now) to there (where they will stand after the plan is implemented). *There* is also where the organization needs to be if it is to survive, so anyone who has looked at the situation with a reasonably open mind can see that the change is not optional. It is essential.

Fine. But then, why don't people "Just Do It"? And what is the leader supposed to do when they Just Don't Do It—when people do not make the changes that need to be made, when deadlines are missed, costs run over budget, and valuable workers get so frustrated that when a headhunter calls, they jump ship. Leaders who try to analyze this question after the fact are likely to review the change effort and how it was implemented. But the details of the intended change are often not the issue. The planned outcome may have been the restructuring of a group around products instead of geography, or speeding up product time-to-market by 50%.

Whatever it was, the change that seemed so obviously necessary has languished like last week's flowers. That happens because transition occurs in the course of every attempt at change. Transition is the state that change puts people into. The change is external (the different policy, practice, or structure that the leader is trying to bring about), while transition is internal (psychological reorientations that people have to go through before the change can work).

The trouble is most leaders imagine that transition is automatic—that it occurs simply because the change is happening. But it does not. Just because the computers are on everyone's desk doesn't mean that the new individually accessed customer database is transforming operations the way the consultants promised it would. And just because two companies (or hospitals or law firms) are now fully *merged* does not mean that they operate as one or that the envisioned cost savings will be realized.

Process of Transitions

Even when a change is showing signs that it may work, there is the issue of timing, for transition happens much more slowly than change. That is why the ambitious timetable that the leader laid out to the board turns out to have been wildly optimistic: it was based on getting the change accomplished, not on getting the people through the transition.

Transition takes longer because it requires that people undergo three separate processes, and all of them are upsetting.

Saying Goodbye: The first requirement is that people have to let go of the way that things—and, worse, the way that they themselves—used to be. As the folk-wisdom puts it, "You can't steal second base with your foot on first." You have to leave where you are, and many people have spent their whole lives standing on first base. It is not just a personal preference you are asking them to give up. You are asking them to let go of the way of engaging or accomplishing tasks that made them successful in the past. You are asking them to let go of what feels to them like their whole world of experience, their sense of identity, even *reality* itself.

On paper, it may have been a logical shift to self-managed teams, but it turned out to require that people no longer rely on a supervisor to make all decisions (and to be blamed when things go wrong). Or it looked like a simple effort to merge two work groups, but in practice it meant that people no longer worked with their friends or reported to people whose priorities they understood.

Shifting into Neutral: Even after people have let go of their old ways, they find themselves unable to start anew. They are entering the second difficult phase of transition. We call it the neutral zone, and that in-between state is so full of uncertainty and confusion that simply coping with it takes most of people's energy. The neutral zone is particularly difficult during mergers or acquisitions, when careers and policy decisions and the very *rules of the game* are left in limbo while the two leadership groups work out questions of power and decision making.

The neutral zone is uncomfortable, so people are driven to get out of it. Some people try to rush ahead into some (often any) new situation, whereas others try to back-pedal and retreat into the past. Successful transition, however, requires that an organization and its people spend some time in the neutral zone. This time in the neutral zone is not wasted, for that is where the creativity and energy of transition are found and the real transformation takes place. It is like Moses in the wilderness: it was there, not in the Promised Land, that Moses was given the Ten Commandments; and it was there, and not in the Promised Land, that his people were transformed from slaves to a strong and free people.

Today, it will not take 40 years, but a shift to self-managed teams, for instance, is likely to leave people in the neutral zone for 6 months, and a major merger may take 2 years to emerge from the neutral zone. The change can continue forward on something close to its own schedule while the transition is being attended to, but if the transition is not dealt

with, the change may collapse. People cannot do the new things that the new situation requires until they come to grips with what is being asked.

Moving Forward: Some people fail to get through transition because they do not let go of the old ways and make an ending; others fail because they become frightened and confused by the neutral zone and do not stay in it long enough for it to do its work on them. Some, however, do get through these first two phases of transition, but then freeze when they face the third phase, the new beginning. For that third phase requires people to begin behaving in a new way, and that can be disconcerting—it puts one's sense of competence and value at risk. Especially in organizations that have a history of punishing mistakes, people hang back during the final phase of transition, waiting to see how others are going to handle the new beginning.

Helping Others to Change

Understanding the transition process is a requirement for almost any senior executive. However, it is when the organization is in transition that leaders themselves often need help. They are so close to the changes that have been initiated that they fail to grasp the real essence of what must be done to help lead themselves and others through the process in an effective manner.

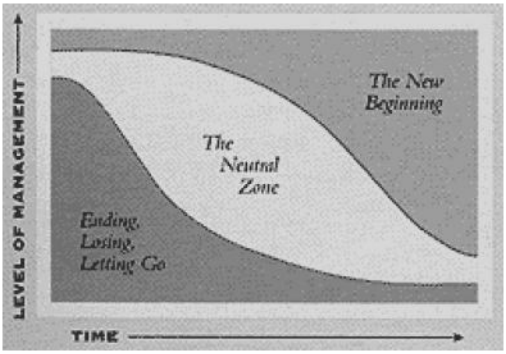
The following are some of the major fail points to consider when attempting to help others to change:

- Remember that they themselves took some time to come to terms with the necessary change and that their followers will need at least as long to do so.
- Understand why anyone would not embrace change, and, so believe that their followers are ignorant, rigid, or outright hostile to the new direction.
- See that it is the transitions, not necessarily the changes themselves that are holding people back and thereby threatening to make their change unworkable.

Most leaders come from backgrounds where technical, financial, or operational skills were paramount, and those skills provide little help when it comes to leading people through transition. Such leaders may be pushing the limits of their understanding of the future, and they need perspective and advice. That is where a trusted colleague, confidant, coach, or consultant can offer valuable counsel to the leader. This

Bridges' Marathon Effect

According to William Bridges, the higher a leader sits in an organization the more quickly he or she tends to move through the change process. Because they can see the intended destination before others even know the race has begun, senior managers can forget that others will take longer to make the transition: letting go of old ways, moving through the neutral zone, and, finally, making a new beginning.



person's background or professional affiliation can vary widely; what matters is that she or he understands how to help people through transition. It is a role that is far more interpersonal and collaborative than is played by most consultants or trainers accustomed to teaching a skill or prescribing a solution.

No training program can prepare a leader for managing a transition. Yet no leader can effectively lead change—which is what leadership is all about—without understanding and, ultimately, experiencing—the transition process. What leaders need, instead, is individualized assistance whereby they learn to

- Create plans to bring their followers through the particular transition that they face—not through generic *change*. A trainer can teach leaders a generalized approach ("The Ten Steps…"), but a good coach can help the leaders to discover their own best approaches.
- Work with their own goals, limitations, and concerns to create a development plan that prepares them for the future.

Few leaders know how to prepare for the challenges that lie ahead.

Times of transition are becoming the rule rather than the exception. Yet few leaders know how to prepare for the changes that lie ahead. Transition leadership skills must be congruent with, must capitalize and build on, the leader's own strengths and talents. They cannot be found in a set of theoretical leadership skills.

Managing Complex Change

This very practical and easy-to-understand change model (Figure 16.2) has been widely used (and adapted) in education and other organizational development work. Many users have modified the general look of the table or the outcome descriptors in the last column. We share David Mann's (p. 24) basic belief that *discipline* is an essential ingredient; as is patience. It takes time and much concerted effort to successfully implement Lean. Too many conversions are *abandoned* because satisfactory results did not come quickly enough and/or at an acceptable cost.

The model clearly identifies key factors for successful change initiatives and reveals what can result when any one of the six dimensions are missing.

Vision	+	Knowledge/ skills	+	Incentive(s)	+	Resources	+	Action plan	+	Discipline/ patience	=	Successful/ change
		Knowledge/ skills	+	Incentive(s)	+	Resources	+	Action plan	+	Discipline/ patience	=	Lack of commitment
Vision	+			Incentive(s)	+	Resources	+	Action plan	+	Discipline/ patience	=	Anxiety
Vision	+	Knowledge/ skills	+			Resources	+	Action plan	+	Discipline/ patience	=	Gradual change
Vision	+	Knowledge/ skills	+	Incentive(s)	+			Action plan	+	Discipline/ patience	=	Frustration
Vision	+	Knowledge/ skills	+	Incentive(s)	+	Resources			+	Discipline/ patience	=	Confusion
Vision	+	Knowledge/ skills	+	Incentive(s)	+	Resources	+	Action plan			=	Abandoned course

FIGURE 16.2
Change model. (Loosely adapted from a model by Ambrose, D., (1987), *Managing Complex Change*.)

Does your organization communicate a simple and compelling vision? Have you acquired the necessary knowledge and skills through smart hiring and supplemental, ongoing training? That would of course include needed expertise in the social, management, and technical system areas. Do your leaders and managers allocate sufficient time, equipment, and human resources for project implementation and improvement activities? Closely related are incentives. Is it expected that people are going to just *do more* and *suck it up, butter cup* or can they see some extra reward for extra effort? All of these ingredients have to be combined according to a *recipe* or action plan, or chaos can result. This model should be meaningfully considered in periodic, facilitated leadership retreats. The insights gained are invaluable.

Change is not a new concept for leaders or their constituents. Leaders understand by now that organizations cannot be just endlessly *managed*, replicating yesterday's practices to achieve success. Business conditions change and yesterday's assumptions and practices no longer work. There must be innovation, and innovation means change. Yet the thousands of books, seminars, and consulting engagements purporting to help *manage change* often fall short. These tools tend to neglect the dynamics of personal and organizational transition that can determine the outcome of any change effort. As a result, they fail to address the leader's need to coach others through the transition process. And they fail to acknowledge the fact that leaders themselves usually need coaching before they can effectively coach others.

FACILITATING LEAN MANAGEMENT

Facilitators Guide to Lean Management

David Mann's Lean management system is succinctly represented in the following tables (see Figures 16.3 and 16.4):

He presents this more micro-level model as another interesting metaphor for a car. If a Lean management system is a car, then the engine is leader standard work. The visual controls are the transmission and a daily accountability process is similar to the gas pedal and steering wheel. Finally, discipline is the fuel that keeps the car running (Mann, p. 23). It is not the intention of this book to regurgitate all of the above-mentioned specifics in David Mann's Lean management system. We highly recommend its consideration in any Lean implementation, and we have successfully used many of his ideas in our own practice. Get the book; read it; and, apply it!

Element	**Key Characteristics**
Leader standard work	Daily checklists for line production leaders—team leaders, supervisors, and value stream managers—that state explicit expectations for what it means (and how) to focus on the process.
Visual controls	Tracking charts and other visual tools that reflect actual performance compared to expected performance of virtually any process in a Lean operation—production and nonproduction alike.
Daily accountability process	Brief, structured, tiered meetings focused on performance with visual action assignments and follow-up to close gaps between actual results and expected performance.
Discipline	Leaders themselves consistently following and following up on other's adherence to the processes that define the three elements.

FIGURE 16.3
Facilitated elements of Lean management. (From Mann, D., *Creating a Lean Culture: Tools to Sustain Lean Conversions*, Second Edition, CRC Press, Boca Raton, FL, 2010, p. xviii. With permission.)

Supporting Element	**Key Characteristics**
The leadership tasks in an ongoing Lean operation	Subtle but important differences between leading Lean conversion projects and leading ongoing lean operations. (Addressed earlier under leadership.)
Learning Lean management	Work with a sensei; use the production area as the classroom through gemba walks.
Root cause analysis	Standard, basic tools to focus on eliminating the causes of problems rather than settling for workarounds that leave causes undisturbed.
Progressive discipline in a Lean environment	Applying discipline for performance as well as for conduct as a source of support for expected performance in a Lean environment.
Rapid response system	Procedures and technology for summoning quick help from support groups and management is important in finely balanced Lean operations. New relationships between support groups and production areas are an often overlooked critical factor in "911" systems.
Improvement process	How are improvement projects managed when they exceed the scope of the daily task assignment boards?

FIGURE 16.4
Supporting elements in the Lean management system. (From Mann, D., *Creating a Lean Culture: Tools to Sustain Lean Conversions*, Second Edition, CRC Press, Boca Raton, FL, 2010, p. xixi. With permission.)

Appropriate automation	IT networks can be powerful tools in support of Lean production and Lean management. Much of the power in IT for Lean consists of knowing when not to apply it.
Labor planning	A suit of four visual tools for planning the next day's work assignments, rotation plan, and unplanned absences.
HR policies	Changes to pay plans, expectations for rotation, applying discipline for problem performers, break schedules, communications processes, pay grades and classifications, and other *people* issues that help or hinder a Lean operation.
Assessing the status of Lean management	A five-level assessment on nine dimensions of Lean management (eight dimensions for office processes) to highlight areas needing attention to bring Lean management practices up to a self-sustaining level.

FIGURE 16.4 (*Continued*)
Supporting elements in the Lean management system. (From Mann, D., *Creating a Lean Culture: Tools to Sustain Lean Conversions*, Second Edition, CRC Press, Boca Raton, FL, 2010, p. xixi. With permission.)

What should supervisors and managers track? Besides regular, ongoing production and service work, the following activities should be consistently monitored:

1. Currently active initiatives
2. Completed process improvement events
3. Number of staff and their managers trained as Lean practitioners
4. Percentage saturation of staff and management participating in learning management system Training
5. Number of cross-organization improvement activities that staff members participate in
6. Number of staff who have completed a transformation awareness online course
7. Number of units/teams routinely huddling
8. Percentage saturation of units/teams routinely huddling
9. Number of units/teams using a visual display board with huddles
10. Number of completed opportunity for improvements

The following guidelines should be considered when attempting to facilitate at the early deployment stages of a Lean management system:

- It is imperative to be careful with selecting your first Lean practitioners.
- Training should include a good dose of business goal talk.

- Make a clear connection between the unit/team's business goals and their skills matrix.
- Start a deployment calendar early.
- Get executive teams huddling first.
- Reinforce, reinforce, reinforce…even if you think you already said it, say it again…FAQs, e-mails, and one-on-one connections.
- Do not rush the slow-pokes; instead slow-down the rushers.
- Create a way to track the fun stories.
- Take plenty of pictures.

Organizational Levels and Alignment

Systems theory talks about levels and alignment. Lean management implementations vary based on the complexity and level of the organization: strategic/organization; system/process; project team/work unit; and team member/personal. Facilitation needs to occur at each of these levels with a technique called *catchball* to ensure that there is adequate communication and policy deployment. They must also address the different components of the Sweet Sixteen: goals, design, management, and, metrics (see Figure 16.5):

	Goals	Design	Management	Metrics
Strategic/ organization	Gameplan (PVV)	Enterprise or organization design	Strategic plan	Balanced scorecard/BSC (highest level, aggregate measures)
Systems/ process	System/ process goals	Value stream design	Process management (Includes daily accountability)	Process (visual controls for input, process, and output measures)
Project team/ work unit	Team charter/ purpose	Work breakdown structure	Project management	Project team/work unit measures (visual controls for on time, on budget, and outcome measures)
Team member/ personal	Personal mission	Job design (includes leader standard work)	Task/time management	Individual performance measures (attendance, participation, and skills demonstrated)

FIGURE 16.5
The Sweet Sixteen Systems model. Developed by Frank Voehl of Strategy Associates, this model is expanded to include 4 performance levels and 4 categories and is loosely based upon the Rummler and Brache approach.

THE ORGANIZATION AS A SYSTEM*

> "A system is a whole made up of parts. Each part can affect the way other parts work and the way all parts work together will determine how well the system works. This is a fundamental challenge to traditional management thinking. Traditionally we have learned to manage an organization by managing its separate pieces (sales, marketing, production, logistics, service, etc.). Managing in this way always causes sub-optimization; parts achieve their goals at the expense of the whole. Only changing the system solves the problem." (John Seddon, *Vanguard...The Toyota System for Service Organizations*)

The Organization as Systems Thinking

As articulated by Rummler and Brache in their seminal work on organizational systems,† organizations must be understood and managed as systems to understand why an organization performs as it does, rather than as we intended:

- How do the many *system conditions* interact to create *patterns of behavior*, of which *events* are merely instances of those patterns of behavior.
- To understand events and their underlying patterns of behavior, we need to understand how the patterns of behavior result from system conditions, and this requires systems thinking.
- Systems thinking emphasize the interactions of system conditions to produce organizational behavior, as opposed to analysis, which means breaking things into their constituent parts.

* The organization as a system was developed by Frank Voehl of Strategy Associates in 1992, based on his work with the Quality Guru Dr. Edwards Deming and in collaboration with the Deming Electronic Network and Master Facilitator John Seddon. In essence, the systems perspective emphasizes that everything is connected to everything else and that it is often worthwhile to model businesses and processes in terms of flows and feedback loops. Systems thinking stresses linkages, relationships, and flows. It emphasizes that any given employee, unit, or activity is part of a larger entity and that ultimately those entities, working together, are justified by the results they produce. To effectively, nimbly, and proactively adapt to the demands of a rapidly changing environment, all system components—inputs, processes, outputs, and feedback—must be managed.

† Rummler and Brache, in their book, *Improving Performance: How to Manage the White Space on the Organization Chart*, introduced a matrix that identifies nine different concerns that anyone trying to change processes in an organization must consider. The Rummler–Brache methodology has helped everyone involved in business process change to understand the scope of the problem, and it provides the foundation on which all of today's comprehensive process redesign methodologies are based (*Business Process Change*, Paul Harmon).

- For any improvement intervention to be successful, it must take an account of interdependency; a change to one system condition is bound to be influenced by, or have an influence on, other system conditions.

The organization as a system is governed by two key systems laws:

- *The First Law:* Every system or process is perfectly designed to achieve exactly the results it gets. So, even though we may not like the results, we knowingly or unknowingly design the system or process to achieve those results.
- *The Second Law:* If you put good people in a bad system or process, the system or process will win every time.

Whether an organization is concerned with customer satisfaction, quality, productivity, cycle time or cost, the underlying issue for facilitators to key in on is *performance*. To improve performance, it is necessary for facilitators to understand the variables that influence performance at the organization, process, and individual job/performer levels.

All organizations are systems and the Rummler–Brache model describes all of the things that a mature organization must master. The thinking here is that an organization's strategic and operational effectiveness is the product of three levels of performance: the organizational level, the process level, and the job/performer level. As a result, every improvement effort must be seen through the lens of the three levels.

- Three performance needs must be met at each level: goals, design, and management.
- Failure to manage the nine performance variables is failure to manage the business holistically.
- Cross-functional processes are particularly critical to the customer satisfaction, quality, productivity, cycle time, and cost performance of any business.
- Managing people should include addressing the needs of all components of the human performance system (performance specifications, task support, consequences, feedback, skills/knowledge, and individual capacity) in which they work.

The point at which many organizations struggle is that they do not have the measurement systems or the general insights to understand how their

overall business decisions create impacts within and without the organization, and how changes to parts of the system impact in a positive or negative manner other parts of the system. For example, Dr. Deming often told us during his 4-day seminars that surgeons would never just start cutting on various body parts without considering the impact on the heart, brain, and other various organs and systems. He would then postulate the question: So why do managers sometimes make changes to processes, technology, workforce policy, customer-facing processes, and so forth without first gathering requirements and then studying the impacts of various potential changes to the system?

We believe that successful management of overall organizational performance requires synthesis, alignment, and integration of the organization's various parts. According to the Baldrige framework:

- *Synthesis* means looking at your organization as a whole and building on key organizational attributes, including core competencies, strategic objectives, action plans, and work systems.
- *Alignment* means using the key linkages between areas of an organization—between its leadership system, planning process, customer focus processes, workforce processes, operations, and other processes—to ensure consistency of plans, processes, measures, and actions. The result of better alignment is more predictable and ever-improving outcomes.
- *Integration* builds on alignment, so that the individual components of an organization's performance management system operate in a fully interconnected manner and deliver anticipated results.

For an organization, then, having a systems perspective means the following:

- Senior leaders focus on strategic directions and customer/stakeholder needs, in that strategies must be linked with work systems and key processes.
- An organization's resources are aligned to strategic objectives to improve overall performance.
- Senior leaders monitor, respond to, and manage performance based on data—on results; in fact, workers at all levels of an enterprise use measures, indicators, and organizational knowledge to make decisions and to improve the processes used throughout the system.

- Organizations can learn: they operate as a closed-loop systems, where data and information inform decision making so that processes can be adjusted, strategies can be *course-corrected*, and core competencies can be fully leveraged.

In essence, a systems perspective means managing your whole organization, as well as its individual components, to achieve success. At each of the three levels (see Figure 16.5), there are tools that can help in documenting, analyzing, and improving performance.

We will address the components at the four levels beginning at the top. Goals at the organization level are known as the *game plan* and they usually encompass the purpose (mission), vision, and values (PVV). These three crucial items also form the beginning of the strategic plan. The purpose or mission is a brief statement of why the organization exists and what it does. The vision is a concise statement of some ideal future state, and the values are what is important to the organization.

These items give direction and they can inspire workers if crafted correctly. The organization design or enterprise map is a high-level representation of the different businesses contained within the larger, umbrella organization. General Electric, for example, participates in separate businesses including the generation, transmission, and distribution of electricity; lighting; industrial automation; medical imaging equipment; motors; railway locomotives; aircraft engines and aviation services; and financial services. Where would a Lean implementation start with this kind of corporate size and complexity?

The PVV is created through an all important environmental scan or strengths, weaknesses, opportunities, and threats analysis and it is operationalized under the management column with the addition of goals, objectives, and strategies. Strategic planning includes both the development and the implementation phases. Organizations do a relatively good job with the first part, but often fail miserably with implantation. They create *pretty plans* and leave them on office shelves to gather dust. Metrics at the organization level are usually aggregated *roll-ups* of lower level measures. These high-level metrics are tied to the strategic goals and they include numerical targets. They are often represented in some form of balanced scorecard and tracked on electronic dashboards. Good dashboards allow for lower level drill downs.

Systems are groups of related processes. In Lean, they are often organized in value streams and their high-level goals usually relate to time, quality, and/or cost. Value streams are usually designed to show inputs entering the system or value stream from the upper left portion of a

value stream map and the outputs for the customers exit the system in the upper right corner. The upper center portion usually contains boxes that represent administration, planning/research, IT, and other support areas. The related production and/or service processes are then arrayed along the bottom with data for capacity and key performance metrics.

Finally, there can be carefully placed symbols for information alerts, transportation, parts supermarkets, and so on. The process and other boxes are arranged to show the direction of the process *flows*. The individual processes are managed with visual controls for important data, frequent and often daily supervisory meetings, regular follow-up on assignments, and standard work. A value stream manger oversees the system in a very cross-functional manner. Lean metrics such as work in process, takt time, pitch, and process efficiency are used to manage.

Project teams or work units are either smaller parts of the larger process units or they are ad hoc groups put together to solve problems and make improvements. Improvement teams are usually "commissioned with charters that are really simple operational contracts between the management and the team." Project goals are included and the teams organize their work with project plans that include work breakdown structures to show the general and more specific tasks and timelines. Metrics often include project management measures for project completion on time and on budget and there can be new process targets for improvements.

The fourth level is often neglected in management systems, but it is crucial. Systems are only as strong as their weakest links who are often individual workers. Larry Senn believes that organizational culture change begins with individual leaders changing their own behavior. Successful work teams select the right people, with complementary skills, and personalities that do not clash excessively. The right team leader must of course be present to facilitate their activities. Employees in work units and teams must have standardized work descriptions and constructive feedback must be regularly given. It helps if the feedback addresses the right individual measures and workers must clearly know what is expected. Successful workers know how to manage their job and personal time, and the two should be balanced. They have professional development plans, access to the right training, and meaningful performance appraisals that help them grow and advance. Their personal metrics should include attendance, work team participation, skills learned and applied, special projects completed, and so on.

The Sweet Sixteen shows the scope and relationships in the generic organization. There is a lot to consider and Lean management implementations are not simple.

CATCHBALL

In a book by Frank Voehl called *Macrologistics Management*,* *Catchball* is described as a simple method that can get your team off to a good start and keep you on target until the goal is achieved.

Toyota and other successful companies use Catchball to create and manage their improvement plans by using the following method:

1. Leaders explain what needs to be done to the team members, who are made up of the people closest to the work to be improved, and are asked to put a plan together to make it happen.
2. Ideas are tossed back and forth while some serious and open debate usually takes place.
3. Next, the team agrees on a *real* plan, which includes assignments with each team member taking responsibility for part of the plan.
4. Everyone agrees and then signs off to signify their commitment.
5. As the team works the plan, a continuing dialogue often will take place. "Are we on the right track? Or do we have the time and other resources required? Also, what are we learning that needs to be incorporated into the plan?"
6. A good many changes are made as a result of this dialogue, while the leader monitors it all and is responsible for the outcome.
7. The leader resolves confusion and helps at key points, but even with all of the things that happen along the way, the constant review and discussion keeps the team on target, until ultimately the goals are accomplished.

The Catchball method works well because those closest to the work are in the best position to put a realistic plan together. Also, it has been shown that if they create their own plan, they take ownership. The continuing dialogue results in adjustments to the plan that ensures *obstacles* do not become *excuses*.

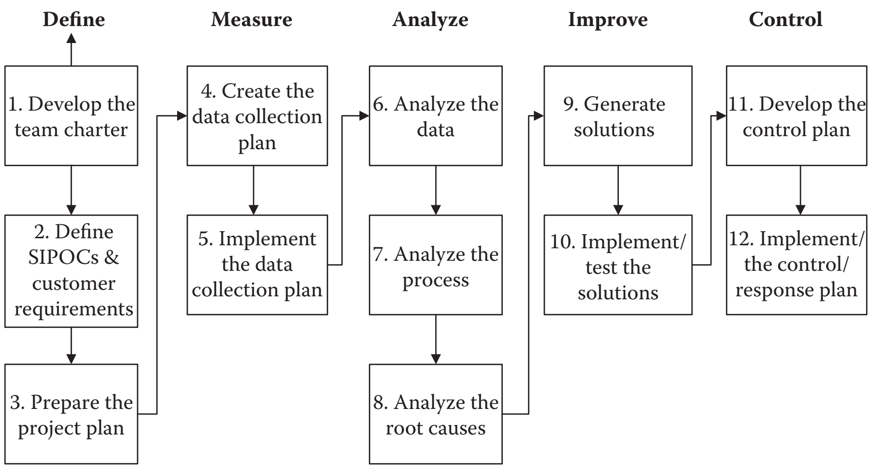
* See *Macrologistics Management* by Frank Voehl and Martin Stein, CRC Press, 1998.

Approach, Deployment, Learning, and Integration

The Malcolm Baldrige Performance Excellence Model is a very helpful tool to assess organizations that apply for their awards: ADLI. This simple method looks first to see what approaches the applicant organizations have developed to address key process issues and criteria. The examiners then check how far down and across the organization these documented approaches have been implemented. Next, are these approaches measured and is there evidence of improvement. What have they learned and done to get better? Finally, are the approaches integrated and aligned. For example, are important initiatives funded and are the workers then trained. Do leaders communicate about the important *things* and is knowledge properly managed. Applicant organizations submit formal written applications that show how they address the Baldrige criteria. Baldrige examiner teams visit the organizations to personally *verify and clarify* the written applications. They are really good at detecting *fresh paint*. ADLI is a great tool for assessing organizations and Lean implementations, but this is a serious work.

DMAIC Roadmap

The most complex Lean projects often apply the DMAIC improvement model and they can last from 3 to 6 months. This duration is influenced by the complexity and difficulty of the project, the number of team members and how long and frequently they meet, and the availability of data. Management becomes very uncomfortable with long projects (beyond 3 months), so they must be strategically important and carefully selected. A good champion is essential.



This approach traditionally included toll-gate reviews after each of the 12 steps, but that can be reduced as long as management is kept informed about barriers and progress. Some steps (e.g., data collection) can be greatly simplified and the number of applied tools should be limited to what is absolutely needed. The DMAIC Roadmap model is more commonly applied with Six Sigma or Lean Six Sigma disciplines, but it is still very effective for longer Lean projects.

Leader Standard Work

Production Status: Culture change in this area is developed through the discipline of leader standard work. The most important item in any production operation is production. In any Lean environment, carefully designed and monitored processes define the production activity. When the process operates as designed, defined, and refined, it meets its goals for safety, quality, delivery, and cost. One of the primary responsibilities of leaders in a Lean management system is to see that the production process runs as designed, and the second is to improve the process.

The production operation is most likely to run as designed when the operators doing the actual production and related jobs are following their standardized work. If they are, things should run predictably.

For these reasons, standard work for leaders is built (or layered) from the bottom up, usually based on standard work procedures (see Figure 16.6) at the value-adding level, as shown in the following table in David Mann's *Creating a Lean Culture* book (pp. 41, 42):

Daily Accountability Process

The table of work shows examples of leader standard work that are performed at four tiers or levels of the organization from the team leader up to the plant manager (and other executives). Note that each tier has specific duties and schedules. Also, each higher tier reviews the work of the lower tier and they all go to gemba or manage by walking around. These review meetings are very brief (5–15 minutes), are conducted close to where work is performed, and people usually stand during the meeting. These short meetings or huddles are carefully planned, highly structured, standardized, and appropriately repetitive. Everyone in charge at each tier goes to gemba, reviews visual controls, makes assignments, and then follows up on those tasks. The table of work shows the specific activities that occur daily and frequently several times a day at the lowest levels. Assignments are given for *misses* and other

Frequency	Team Leaders (TL)	Supervisors (Supe)	Value Stream Managers (VSM)	Plant Managers (PM), Exec's (When in Plant)
Once daily, typically repeated each day (or each occasion for plant managers and executives)	Check call-ins Adjust labor plan	Shift change coordination Daily admin tasks	Daily admin tasks	Review performance trend charts
	Lead team start-up (tier 1) meeting (5–10 min)	Attend a TL start-up meeting	Night shift gemba walk	Spot-check, sign-off pitch charts, other visual controls
	Floor check production start-up	Floor check production start-up	Lead value stream task/improvement (tier 3) meeting (10–20 min)	Lead weekly plant performance/improvement review meeting (PM)
	Supe-TLs (tier 2) meeting (5–15 min)	Lead (tier 2) meeting w/TLs • Misses, issues, improvements • Daily task board due and new items	Daily gemba walk w/one supe	Spot-review process and product improvement review meeting (PM)
	Gemba walk w/supervisor	Attend weekly recurring plant-level meeting	Formal audit of one area	Verify leaders' standard work
	Supe-TL meets accountability, improvement (5–15 min)	Gemba walk w/TLs one on one	Attend weekly recurring plant-level meeting	Verify TL, supe on floor, or why not?
	Daily (weekly) continuous improvement meeting w/team	Spot-check buzzer-to-buzzer work		

FIGURE 16.6
Typical items in leader standard work. (From Mann, D., *Creating a Lean Culture: Tools to Sustain Lean Conversions*, Second Edition, CRC Press, Boca Raton, FL, 2010, pp. 41–42. With permission).

Frequency	Team Leaders (TL)	Supervisors (Supe)	Value Stream Managers (VSM)	Plant Managers (PM), Exec's (When in Plant)
	Next day planning • Labor plan • Prep for team start-up meeting	Spot-check, sign-off each pitch chart Review status of other visuals		Gemba walk with each VSM, staff manager weekly (PM)
Many times daily, often specified by time of day or number of items	Monitor buzzer-to-buzzer work before and after breaks	Spot-check standardized work in each TLs area	Spot-check buzzer-to-buzzer work	Floor time
	Verify pitch by performance • Record reasons for variation • Note, act on flow interrupters	Floor time	Spot-check, sign off pitch charting in each department. Spot-check other visuals	
	Monitor standardized work in each station • Check compliance • Reinforce, correct performance as needed		Spot-check standardized work in each department	
	Revise production standard work as needed		Floor time	
	Train operators			

FIGURE 16.6 (*Continued*)
Typical items in leader standard work. (From Mann, D., *Creating a Lean Culture: Tools to Sustain Lean Conversions*, Second Edition, CRC Press, Boca Raton, FL, 2010, pp. 41–42. With permission).

problems and TLs and supervisors perform a lot of the process improvement problem-solving tasks. Assignments are also charted daily and progress is shown with red and green dots. Green dots are placed next to all tasks that were successfully completed on time. Red dots are placed next to delayed or inadequately performed assignments. A green dot is placed next to the reds dots once that task is successfully completed. Employee suggestions are also tracked on visual charts including supervisor follow-up. Visually displaying results tends to promote improved performance. People are competitive and they like to avoid the shame of publicly advertised poor performance.

Visual Controls

David Mann's Lean management system relies on visual controls. In fact, he recommends that organizations develop and improve their data and visual controls before they focus on creating leader standard work. Besides the traditional use of control charts, traffic light colors, signs, borders and arrows, and so on, he employs some interesting charts. His pitch charts include boxes for expected work, actual work, percentages, time periods, and most importantly, misses. The misses are the brief explanations about problems that occurred and work targets were not met. These can be identified as specific types of muda or waste. See part of one of his production tracking charts in Figure 16.7.

Mann also uses visual controls for daily employee suggestions, accountability assignments, staffing plans, worker rotation plans, worker skill matrices, and load leveling (heijunka). Most importantly, these charts are regularly monitored from multiple tiers to insure compliance.

Area: B211 Assembly
TL: Tina T. **Production Tracking Chart** **Date: 4/27/10**

Pitch	Goal Pitch/ Cumulative	Actual Pitch/ Cumulative	Variation Pitch/ Cumulative	Reason for Misses
7-7:30	20/20	18/18	-2/-2	10 min. startup mtg. Meeting long 2 minutes—safety issue
7:30–8	30/50	30/48	0/-2	
etc.				

FIGURE 16.7
David Mann's Lean management system production tracking chart (partial). (From Mann, D., *Creating a Lean Culture: Tools to Sustain Lean Conversions*, Second Edition, CRC Press, Boca Raton, FL, 2010, p. 57. With permission.)

SOME TOOLS TO FACILITATE LEAN MANAGEMENT SYSTEM ANNUAL IMPROVEMENT PROJECTS

Use of Project Charters

The charter begins with a brief business case/problem statement. This is the compelling reason for forming the team and undertaking the work. Baseline trend data is included. This part should ideally be completed by management so that the new team does not have to *sell* management on the *idea*. The project scope, timeframe, and target sections are also extremely important because they provide the new group boundaries and goals to strive for. The scope defines what is included and excluded. The resources section is closely related. The size of the project and the available staff, equipment, funding, and time resources should be realistically related to management's expectations. These important decisions can *facilitate* success or guarantee failure. The last section lists the project team members and it will be addressed below. All of these items require careful negotiation and the project champion and TL/facilitator play key roles. Figure 16.8 contains an example of a charter and there are many others. It is most important to keep them simple.

Project selection is an important leadership activity because resources such as the time of valued employees and funding are always limited. Leaders need to make these decisions wisely and it helps to apply a set of standard criteria to this type of critical thinking (see Figure 16.9).

PROJECT CHARTER WORKSHEET **Project Title:** **Date:**	
Business Case/Problem Statement:	**Initial Goal Statement(s):**
What is the problem? Be specific and include data, etc.	Create 1–4 goals addressing time, quality (defects), cost, and/or satisfaction. Make them SMART and include baseline measures and numerical targets.
What specifically will happen if you do not do the project?	

FIGURE 16.8
Project charter worksheet. (Adapted from Strategy Associates Lean Six Sigma Green Belt [Strategy Associates is wholly owned by the authors] training materials.)

PROJECT CHARTER WORKSHEET (*Continued*)			
Project Scope & Constraints:	**Customers/Stakeholders:**		
What are you going to do? What specifically should be included in the project?			
What specifically should be excluded or limited?			
Resources Needed for Project		**Project Start Date**	**Completion Date**
Team Members	**Role**	**Team Members**	**Role**
	Champion		Member
	Leader		Member
	Facilitator		Member
	Member		Member
	Member		Member
Leadership Approval			
Signature of Sponsor		**Date Approved:**	
Name of Sponsor			

FIGURE 16.8 (*Continued*)
Project charter worksheet. (Adapted from Strategy Associates Lean Six Sigma Green Belt [Strategy Associates is wholly owned by the authors] training materials.)

Rating Items	Weights	Scores for Projects Being Rated			Totals
		Project 1	Project 2	Project 3	
1. Are customers (internal/external) dissatisfied with inventory practices or defecting?	3				
2. Is the inventory control process stable?	3				
3. Is the specific defect level (defined by customer) known?	4				
4. Is data related to the inventory or other defect available or collectable?	5				
5. Is the solution not obvious?	3				

FIGURE 16.9
Project selection matrix template.

Rating Items	Weights	Scores for Projects Being Rated			Totals
		Project 1	**Project 2**	**Project 3**	
6. Are the expected inventory control and other benefits significant enough?	**3**				
7. Will service and/or quality and inventory turns be noticeably improved?	**2**				
8. Does the project have champion and sponsor support?	**4**				
9. Is the project aligned with department or company goals and inventory turns improvement?	**3**				
10. Can the project be completed within 100 days?	**3**				
11. Considering the risk, is there a good probability of implementation?	**2**				
12. Will the solution likely involve little or no capital investment?	**4**				
13. Are the necessary team members available to support the project?	**2**				
14. Is the ability to make change in the process largely in our control?	**4**				
15. Will the solution likely not involve redesign of the process?	**3**				
Totals					

FIGURE 16.9 (*Continued*)
Project selection matrix template. *Note:* These matrices can be customized with the use of *weights* that indicate relative importance. For example, the *availability of data* might be rated higher than *probability of success*. Also, critical thinking and fairness are enhanced with the application of a *uniform* set of criteria.

Quality in Daily Work Accountability

As mentioned by David Mann and Norman Bodek, a daily work accountability is a key element of the Lean management system. These tools (see Figures 16.10 through 16.13) mostly come from the project management body of knowledge and they can be quite sophisticated and difficult to use. A basic format includes the action plan example laid out in Figure 16.10.

The items are listed in some logical chronology and multiple items can be *in process* at the same time. Action plans are called *work breakdown* structures when they contain an item numbering system such as: 1, 1.1, and 1.1.1. This format is used in programs such as Viewpath or Microsoft Project. Viewpath is an excellent, inexpensive, online choice that is easy to use. Microsoft Project is the *Cadillac* of these tools, but the learning curve is large and it might be overkill for most projects. It is so complicated that users will forget it if they do not apply it regularly. Action plans are sometimes accompanied with Gantt charts that are great for showing task *overlap* over time. Note the similarity to the action plan in Figure 16.11.

Item	Responsibility	Start Date	End Date	Status/Comments
1. First item	Mary	6/1/2012	6/10/2012	Completed. Good feedback
2. Second item	Sam	6/1/2012	7/15/2012	Completed. Some rework
3. Third item	Mary	6/15/2012	7/20/2012	In process
4. Fourth item	Susan and Joe	7/1/2012	8/15/2012	In process
5. etc.	etc.	etc.	etc.	etc.

FIGURE 16.10
Action plan example.

Items	Time Periods			
	June	July	August	ect.
1. First item	X			
2. Second item	X	X		
3. Third item	X	X		
4. Fourth item		X	X	
5. etc.				

FIGURE 16.11
Gantt chart example.

Strategy associates has successfully applied the templates in Figures 16.12 and 16.13.

Actions	Responsible Person(s)	Start Date	Due Dates	Status	Comments
1. Gather existing data to determine current situation					
2. Determine if new/more data is needed					
3. Decide what additional data is needed					
4. Determine customer requirements if not already done					
5. Develop operational definitions for new measures					
6. Decide how much new data is needed based on confidence level, and so on					
7. Decide where to get the new data					
8. Decide how to collect the new data					
9. Determine the time/date range for the new data					
10. Decide who will get additional data					
11. Develop (and pilot) any new instruments					
12. Train the data collectors					
13. Collect the data					
14. Prepare the data for analysis					
15. Conduct an MSA					

FIGURE 16.12
Basic data collection plan.

Actions	Responsible Person(s)	Start Date	Due Dates	Status	Comments
16. Repeat any of the above steps, if needed (e.g., pilot studies in Improve)					
17. On-going collection and monitoring of necessary data					

FIGURE 16.12 (*Continued*)
Basic data collection plan.

Root Causes	Solution	Effort Needed to Implement	Cost to Implement	Time to Implement	Potential Impact/ Effectiveness	Totals
			Ratings for Proposed Solutions			

Key	
Effort	Minimum: 7–10
	Moderate: 4–6
	Maximum: 1–3
Cost	Minimum: 7–10
	Moderate: 4–6
	Maximum: 1–3
Time	Minimum: 7–10
	Moderate: 4–6
	Maximum: 1–3
Impact	Maximum: 7–10
	Moderate: 4–6
	Minimum: 1–3

FIGURE 16.13
Solution selection matrix.

Note that this data collection plan begins with a specific project and the currently available data that addresses that project. It includes the X's and Y's and types of data along with the amounts and trends. What follows are stratification, stability, evidence of measurement system analysis, and so on to deduce existing reliability and validity. These steps are repeated for

additional data that might be needed and a generic data collection action plan is offered. This is rather complex, but measurement is serious. In fact, we encourage the involvement of statisticians at the earliest stages of this process. They can help you gather the right amounts of the right data. This takes resources, so it is best to "do it correctly."

SUMMARY

Most things in our lives are parts of larger systems, where various parts of the system interact and affect various other parts of the system. As described in this chapter, systems thinking is the process of understanding how things influence one another within a whole. Organizational systems theory dates back several decades and few have had the privilege of working closely with some of the experts like Deming, Ackoff, and Wheatley, among others. Collectively, these experts have all emphasized that organizations were highly complex systems, and that managers should therefore manage organizations as systems, rather than merely focusing on its individual parts. In fact, these experts believed managers should view problems as parts of an overall system, rather than only reacting to specific events, failures, or process problems, the result of which could contribute to unintended consequences.

As the Rummler–Brache model clearly emphasizes, systems perspective is based on the belief that the component parts of a system can best be understood in the context of relationships with each other and with other systems, rather than in isolation. And a systems perspective focuses on cyclical, rather than linear, cause-and-effect relationships within and between organizations.

The organization as a system has at its core a third circle in the systems' Venn diagram—the Technical System—which refers to all of the technologies and *tools* that can be used to plan for, manage, and design/improve Lean organizations. This would include computers/software and other automation, which will not be the focus of this chapter. When applied correctly, automation greatly facilitates the use of all tools, even though it can exact a cost as far as a decreased need for workers. That partly explains the *jobless recovery* that economies are currently suffering through.

There are a large number of planning, management, and improvement tools to choose from and a 2012 survey of quality professionals named

over 1200 (Harrington 2012). This number was purposefully limited in this section of the handbook because the focus is on the facilitation of some of the most important and useful tools. By facilitation, we specifically mean simplification and clarification. Remember, facilitation is also about making things *easier*.

Visual controls analysis can create the tie to a visual analysis of the waste in the process and can be used on a monthly basis as part of the leader standard work. Facilitators will need to focus on the monitoring part, which usually includes the use of control charts for important X and Y metrics.

This is a very important phase of the Lean management systems deployment because the data, processes, and root causes must be carefully examined before solutions can be considered. Data analysis must be completed before subsequent analyses or you face a "garbage in: garbage out" scenario. The accepted tool for data analysis was referenced in the previous measurement section, but further discussion is a little too technical for this chapter. The status of every process should be displayed in a visible manner for every core value stream and associated process. Lean management systems are designed and implemented so that the high impact core value streams and related key processes meet the valid customer requirements for time, quality, cost, satisfaction, and so on. This is the primary challenge of measurement and it must be remembered that "if you cannot measure work, you cannot manage or improve it."

Toward that end, Lean management systems include measurement systems such as the one represented in the models shown in this chapter. When the data does not exist, improvement teams will have to collect it.

REFERENCES

1. Davide Ravasi and Majken Schultz, Responding to organizational identity threats: Exploring the role of organizational culture, *Academy of Management Journal*, June 2006, Vol 29 No. 3, Pgs 433–458.
2. David Mann, *Creating a Lean Culture: Tools to Sustain Lean Conversions*, Second Edition, CRC Press, Boca Raton, FL, 2010.

Epilogue: The Shadow of the Leader in a Systems Thinking Environment

If your actions inspire others to dream more, learn more, do more, and become more, you are a Leader.

John Quincy Adams

As authors and consultants, we believe that the greater the sum total of management thinking and thinkers in the organization, the more readily and effectively the organization can respond to and take advantage of the vast array of changes occurring in today's business environment. However, despite the significant levels of de-layering and flattening of structures that has taken place in the last decade or so, some organizational barriers continue to stifle opportunities for accelerating Lean management systems thinking. This limits the flow of experiences and insights to relevant corners of the organization.

This handbook in the Management for Results series is intended to help you take a step back and look at your team or organization's systems, processes, and culture to clearly see the reflection of your leader–facilitator style. The reflection you see may be a difficult thing for you to handle, but do not respond by trying to defend or to rationalize it as something not being of your making. As difficult as it may be, managers need to face the reality that their Lean management system and organization's culture are a reflection of their leadership; leading to the concept of the leader–manager. Accepting this responsibility is the first step to change, and as we all know, change begins with ourselves.

This is a particularly exciting and turbulent time in the field of Lean management, both domestically and globally, and change may be viewed as either an opportunity or a threat. As such, the principles and practices

of management for results can aid in this transformation or (by flawed implementation approaches) can bring an organization to its knees. This Management for Results series (and this handbook contained therein) discusses the relationships between management thinking, results orientation, management planning, and emergent strategy, and suggests that management thinking needs to be compressed and accelerated, as it is essential in making these relationships more appropriate and effective—a so-called shadow of the leader.

The shadow of the leader that is present throughout this handbook is based on the following eight characteristics of an effective leader–facilitator–manager who gets results, and provides one of the many integration frameworks around which this handbook and the entire series is based:

1. *Integrity:* The integration of outward actions and inner values
2. *Dedication:* Spending whatever time or energy necessary to facilitating the task at hand, thereby leading by example and inspiring others
3. *Magnanimity:* Giving credit where it is due
4. *Humility:* Acknowledging they are no better or worse than other members of the team
5. *Openness:* Being able to listen to new ideas, even if they do not conform to the usual way of thinking
6. *Creativity:* The ability to think differently, to get outside of the box that constrains solutions
7. *Fairness:* Dealing with others consistently and justly
8. *Assertiveness:* Clearly stating what is expected so that there will be no misunderstandings and dealing with poor performance

If a good leader's actions inspire people to dream more, learn more, do more, and become more (and those actions will lead to an organization's culture, and if the culture represents "the way we do things around here"), then this handbook in the Management for Results series represents a brief glimpse of the shadow of the leader. This handbook as a compilation of conceptual management framework and literature review on the latest concepts in management thinking, speaks to accelerating performance and achieving rapid and long-lasting results. It examines some of the more recent as well as historical contributions, and identifies a number of key elements involved. Further analysis determines a number of situations that can improve the result-oriented thinking capability in managers,

and this edition considers whether organizations can successfully adopt their content and conclusions to develop their managers and improve the culture of their business to accelerate performance and achieve more rapid results.

As Gandhi said many years ago, we all need to strive to become the "change we want to see in the world." In the case of *facilitating management for results*, we need to be the change we want to see in others!

Appendix A: Lean Six Sigma Body of Knowledge

The following is a list of the Lean Six Sigma body of knowledge (Table A.1). Under the columns marked *Green*, *Black*, or *Master* belts, the following symbols are used:

- "A" means they are almost *always used*. At least 90% of the projects will use these tools. (The related belt must be trained on how to use these tools or already has been trained in the use of these tools.)
- "O" means *often used*. It is used in more than 50% of the projects. (The related belt should be trained on how to use these tools or already has been trained on these tools.)
- "S" means *sometimes used*. It is used in 25%–49% of the projects. (The related belt should know what they are used for and know where to go to get more information on how to use them.)
- "I" means *infrequently used to never used*. It is used in less than 24% of the projects. (These tools are nice to know but not required and not part of the belt's training or certification test.)

TABLE A.1

Lean Six Sigma Body of Knowledge

Body of Knowledge	**Lean Six Sigma Belts**		
	Green	**Black**	**Master**
Acceptance decisions	I	S	S
Activity network diagrams	S	S	S
Affinity diagrams	S	O	O
Area activity analysis	S	I	I
Automation	I	S	S
Axiomatic design	I	S	S
Bar charts/graphs	A	A	A
Benchmarking	S	O	O
Bessel function	I	S	O
Binomial distribution	O	O	O
Bivariate distribution	I	S	O

(*Continued*)

TABLE A.1 (*Continued*)

Lean Six Sigma Body of Knowledge

Body of Knowledge	**Lean Six Sigma Belts**		
	Green	**Black**	**Master**
Box plots	S	O	O
Brainstorming	A	A	A
Bureaucracy elimination	S	O	O
Business case development	A	O	O
Business process improvement	S	O	O
Business value added	S	A	A
Calibration	O	O	O
Cause-and-effect (fishbone) diagrams	O	O	O
Cause-and-effect matrix	O	O	O
Cellular manufacturing	S	O	O
Central limit theorem	O	O	O
Chi-square distribution	O	O	O
Coefficient of contingency©	I	S	S
Collecting data	A	A	A
Communication techniques	O	O	A
Confidence interval for the mean/proportion/variance	O	O	O
Conflict resolution	O	O	O
Continuous flow manufacturing	S	O	O
Control charts			
X bar-R charts	O	O	O
Run charts	O	O	O
MX bar-MR charts	S	O	O
X-MR charts	S	O	O
X bar-S charts	S	O	O
Median charts	I	S	O
Short run charts	S	S	O
p Charts	O	O	O
np Charts	O	O	O
r Charts	S	O	O
u Charts	S	O	O
Cusum control charts	I	S	S
Correlation coefficient	O	O	O
Cp	O	O	O
Cpk	O	O	O
Cost, quality, features, and availability	S	S	O
Critical to quality (CTQ)	A	A	A
Critical path method	O	O	O
Culture roadblocks	I	O	O

TABLE A.1 (*Continued*)

Lean Six Sigma Body of Knowledge

Body of Knowledge	**Lean Six Sigma Belts**		
	Green	**Black**	**Master**
Cumulative distribution function	S	O	O
Current state mapping	O	O	O
Customer requirements	A	A	A
Customer surveys	S	O	O
Cycle time analysis	S	O	O
Design for maintainability and availability	I	S	S
Design for Six Sigma (DFSS)	I	S	O
Design for X	I	S	O
Design of experiments			
Three-factor, three-level experiment	I	O	O
Randomized block plans	I	S	O
Latin square designs	I	O	O
Graeco-Latin designs	I	S	O
Full factorial designs	I	O	O
Plackett–Burman designs	I	S	O
Taguchi designs	I	O	O
Taguchi's robust concepts	I	S	O
Mixture designs	I	S	O
Central composite designs	I	S	S
Evolutionary operations	I	I	S
DMADV (define, measure, analyze, design, and verify)	S	O	O
DMAIC (define, measure, analyze, improve, and control)	O	O	O
Effort/impact analysis	I	O	O
Equipment certification	S	S	S
Error proofing	O	O	O
Exponential distribution	I	O	O
External and internal customers	O	O	O
F Distribution	I	S	S
Facilitation of teams	I	O	O
Factorial experiments	I	S	O
Failure mode and effect analysis	O	O	O
Fast action solution technique (FAST)	O	O	S
First time yield or rolled through yield	O	O	O
Five M's (materials, machines, manpower, methods, and measurements)	A	A	A
Five S's	O	O	O

(*Continued*)

TABLE A.1 **(*Continued*)**

Lean Six Sigma Body of Knowledge

Body of Knowledge	**Lean Six Sigma Belts**		
	Green	**Black**	**Master**
5 Why's (5 W's)	O	O	O
Flow charts	O	O	O
Focus groups	S	O	O
Force field analysis	O	O	O
Frequency distribution	O	O	O
Future state mapping	O	O	O
Gantt charts	O	O	O
Gaussian curves	I	S	S
General surveys	O	O	O
Histograms	O	O	O
History of quality	S	S	S
Hypergeometric distribution	I	S	O
Hypothesis testing			
Fundamental concepts	S	O	O
Point and interval estimation	I	S	O
Tests for means, variances, and proportions	I	O	O
Paired comparison tests	I	O	O
Analysis of variance	O	O	O
Contingency tables	S	O	O
Nonparametric tests	S	O	O
Interrelationship digraphs (ID)	S	O	O
Interviewing techniques	O	O	O
IT applications	S	O	O
Just-in-time	I	S	S
Kaizen and you	A	A	A
Kaizen and process troubleshooting	S	O	O
Kaizen and teams	S	O	O
Kaikaku (transformation of mind)	I	S	O
Kakushin (innovation)	I	S	S
Kanban	S	S	S
Kano model	S	O	O
Kendall coefficient of concordance	I	I	S
Knowledge management	I	S	O
Key process input variables (KPIVs)	O	O	O
Kruskal–Wallis one-way analysis	I	S	S
Lean thinking	S	O	O
Levene's test	I	S	S
Lognormal distribution	I	S	S

TABLE A.1 **(*Continued*)**

Lean Six Sigma Body of Knowledge

Body of Knowledge	**Lean Six Sigma Belts**		
	Green	**Black**	**Master**
Loss function	S	O	O
Management theory history	I	S	O
Mann–Whitney U test	I	S	S
Market segmentation	S	S	O
Matrix diagrams	O	O	O
Measure of dispersion	O	O	O
Measurement error	O	O	O
Measurement systems analysis (MSA)	S	O	O
Measurement tools	O	O	O
Method of least squares	O	O	O
Mistake proofing (poka yoke)	S	S	S
Mood's median test	I	S	S
Motivating the workforce	S	O	O
Multi-vari analysis	S	O	O
Multiple linear regression	S	O	O
Negotiation techniques	O	O	O
Nominal group technique	O	O	O
Normal distribution	O	O	O
Normal probability plots	S	O	O
Null hypothesis	S	O	O
Opportunity cycle (protection, analysis, correction, measurement, and prevention)	S	S	S
Project management	A	A	A
Organizational change management	O	O	O
Organizational culture diagnosis	S	O	O
Overall equipment effectiveness (OEE)	S	S	S
Pareto diagrams	A	A	A
Pattern and trend analysis	I	S	S
Plan-do-check-act (PDCA)	S	S	S
Plan-understand-streamline-implement continuous improvement	S	O	O
Point of use storage (POUS)	O	O	O
Poisson distribution	S	O	O
Poka yoke (mistake proofing)	S	S	S
Poor-quality cost	S	S	O
Portfolio project management	I	S	O
Prioritization matrices	O	O	O

(*Continued*)

TABLE A.1 (*Continued*)

Lean Six Sigma Body of Knowledge

Body of Knowledge	**Lean Six Sigma Belts**		
	Green	**Black**	**Master**
Probability concepts	O	O	O
Probability density function	I	S	O
Probability plots	O	O	O
Process capability studies	O	O	O
Process decision program charts	S	O	O
Process elements	O	O	O
Process failpoints matrix	S	S	S
Process mapping	O	O	O
Process performance matrix	S	O	O
Process redesign	S	O	O
Program evaluation and review technique	I	S	S
Poisson series	I	S	O
Project decision analysis	I	S	O
Project financial benefits analysis	A	A	A
Project selection matrix	I	S	A
Pugh concept selection	I	I	I
Pull systems	S	O	O
Quality @ Source	O	O	O
QFD (quality function deployment)	S	O	O
Qualitative factor	O	O	O
Quantitative factor	O	O	O
Reengineering	I	S	O
Regression analysis	S	O	O
Reliability analysis	I	S	O
Response surface methodology	I	S	S
Rewards and recognition	S	O	O
Risk analysis	A	A	A
Risk assessment	A	A	A
Robust design approach	S	O	O
Root cause analysis	A	A	A
Rotation patterns	I	S	O
Run charts	O	O	O
Sampling	O	O	O
SCAMPER (substitute, combine, adapt, modify, put to use, eliminate, rearrange)	S	S	S
Scatter diagrams	O	O	O
Seven basic tools	O	O	O
Sigma	O	O	O

TABLE A.1 (*Continued*)

Lean Six Sigma Body of Knowledge

Body of Knowledge	**Lean Six Sigma Belts**		
	Green	**Black**	**Master**
Sigma conversion table	O	O	O
Signal-to-noise ratio	I	S	O
Simple language	S	O	O
Simple linear regression	S	O	O
Simplification approaches	O	O	O
Simulation modeling	I	S	O
Single-minute exchange of die (SMED)	I	S	O
Six Sigma metrics	I	S	O
Spearman rank correlation coefficient	I	S	O
Stakeholders	O	O	O
Standard work	A	S	S
Statistical process control	O	O	O
Statistical tolerance	S	S	O
Stem and leaf plots	I	S	O
Strengths, weaknesses, opportunities and threats analysis (SWOT analysis)	S	O	O
Structural roadblocks	S	O	O
Student's T distribution	I	S	O
Supplier controls	S	O	O
Supplier, inputs, process, outputs, customers (SIPOC) diagrams	O	O	O
Systematic design	S	S	O
Takt time	S	S	O
Team building	O	O	O
Team charter	A	A	A
Team management	A	A	A
Theory of constraints	S	S	O
Throughput yield	I	S	S
Tollgates	O	A	A
Total productive maintenance (TPM)	S	S	O
Tree diagrams	O	O	O
TRIZ	I	I	I
Types of data	O	O	O
Types of teams	I	S	O
Value-/no-value-added activities	S	O	O
Value stream analysis (mapping)	S	O	O
Value stream management	S	O	A

(*Continued*)

TABLE A.1 (*Continued*)

Lean Six Sigma Body of Knowledge

Body of Knowledge	**Lean Six Sigma Belts**		
	Green	**Black**	**Master**
Variance (o^2, s^2)	I	O	O
Variation analysis			
Rational subgroups	S	O	O
Sources of variability	S	O	O
Randomness testing	S	O	O
Precontrol techniques	I	S	O
Exponentially weighted moving average	I	S	S
Moving average	S	O	O
Visual factory/visual office	S	O	O
Voice of the customer (VOC)	A	A	A
Voice of the supplier	O	O	O
Waste identification	A	A	A
Waste elimination	A	A	A
Weibull distribution	I	O	O
Wilcoxon–Mann–Whitney rank sum test	I	S	S
Work breakdown structure	O	O	O
Work standard	I	S	O
Z value	I	S	O

Appendix B: Glossary

5Ws and 2Hs	A rigid, structured approach that probes into and defines a problem by asking a specific set of questions related to a previously defined opportunity or problem statement. The 5Ws and 2Hs stands for • W1—What? • W2—Why? • W3—Where? • W4—Who? • W5—When? • H1—How did it happen? • H2—How much did it cost?
Acceptable Quality Level (AQL)	The percentage or proportion of defects or defectives that is considered satisfactory quality performance for a process or product.
Acceptance Decisions	This is the process of making the choice to accept or reject an output based on the risk related to accepting that output and/or your evaluation of the output that is provided. Acceptance decision is the highest number of nonconforming units or defects found in a sample that permits the acceptance of the lot.
ABC Inventory	A methodology for determining inventory levels based on value, space consumption, and turns. Generally, the following "rules" apply: (a) "A" type inventory is very expensive (keep as little on hand as is reasonable so you do not tie up too much cash in inventory), (b) "B" type inventory is only moderately or middle-of-the-road expensive (minimize this inventory to free up cash also, but if you have a little extra it would not break the bank), (c) "C" type inventory is fairly inexpensive (If it consumes little space and costs very little do not lose any sleep over it. That said, you should keep this inventory to a reasonable minimum as well.)
Activity-Based Costing (ABC)	A technique for accumulating product cost by determining all costs associated with the activities required to produce the output.
Activity Plan	A simple chart that shows a list of implementation activities listed in sequence. It identifies the individual responsible for a particular activity and the projected timing of that activity.

(*Continued*)

Adaptability	The flexibility of a process to handle future, changing customer expectations and today's individual, special customer requirements. It is managing the process to meet today's special needs and future requirements. Adaptability is an area largely ignored but is critical for gaining a competitive advantage in the marketplace. Customers always remember how you handle or to not handle their special needs.
Advantage/ Disadvantage Technique	Lists of advantages and disadvantages of each proposed solution are made. The solution of the most favorable ratio of advantages to disadvantages is assumed to be the best solution.
Advocate	An individual/group that wants to achieve change but does not have sufficient sponsorship.
Andon Board	A visual control device in a production area, typically a lighted overhead display, giving the current status of the production system and alerting team members to emerging problems. A "visual control" device that indicates the "status" of a machine, line, or process. Frequently, audible alarms or warning messages accompany Andon status lights as a secondary method of communicating a problem has arisen. Andons are typically color-coded with these generic colors: (a) green (normal operations), (b) yellow (it is time for a changeover or planned maintenance), (c) red (a problem has occurred, the machine or line is "Down," and "Urgent Attention" is needed). Andons can be very effective in highly automated processes to alert support personnel of problems who must attend to several automated processes at a time or are not located in close proximity to the machines they oversee.
Appraisal Costs	These are the costs that result from evaluating already completed output and auditing the process to measure compliance to established criteria and procedures. To say it another way, appraisal costs are all the costs expended to determine if an activity was done right every time.
Area Activity Analysis (AAA)	A proven approach used by each natural work team (area) to establish efficiency and effectiveness measurement systems, performance standards, improvement goals, and feedback systems that are aligned with the organization's objectives and understood by the employees involved.
Area Graphs	Convenient methods of showing how 100% of something is apportioned. The most commonly used area graph is the pie chart.
Arrow Diagrams	A way to define the most effective sequence of events and control the activity to meet a specific objective in a minimum amount of time. It is an adaptation of PERT (Program Evaluation and Review Technique) or the CPM (Critical Path Method).
Ask "Why" 5 Times	A systematic technique used to search for and identify the root cause of a problem.

Assumption Evaluation Provides a way of redefining problem statements, analyzing solutions, and generating new ideas.

Attribute Control Chart A plot of attributes data of some parameter of a process' performance, usually determined by regular sampling of the product, service, or process as a function (usually) of time or unit number or other chronological variables. This is a frequency distribution plotted continuously over time, which gives immediate feedback about the behavior of a process. A control chart will have the following elements:

- Center Line (CL)
- Upper control limit (UCL)
- Lower control limit (LCL)

Attributes Data This is counted data that can be classified as either yes/no, accept/reject, black/white or go/no-go. These data are usually easy to collect because they require only counting and are not measuring the process, but they often require large samples.

Automation The use of robots, machinery, or software to eliminate repetitive and boring jobs previously done by people. Automation is the automatic operation and control of machinery or processes by devices such as robots that can make and execute decisions without human intervention.

Autonomation Automation with a human touch. Refers to semiautomatic processes where the operator and machine work together. Autonomation allows man—machine separation; stopping a machine automatically or without intervention when a defective part has been created. Some forms of autonomation do include human intervention to detect defective parts, but the ideal is to have a machine detect a defective part and then correct the problem on its own. Autonomation devices can be very complex involving sensing equipment, lasers, scales, and so on, or it can be as simple as parts not being able to pass through a dimensional gauge. This method typically causes a backing-up of the system, which at some point triggers a shut-down switch or alarm to gain operator attention to the problem (Note: Also referred to Jidoka.)

Average Incoming Quality (AIQ) AIQ is that average quality level going into an inspection point.

Average Outgoing Quality (AOQ) AOQ is the average quality level leaving an inspection point when the rejected parts have been removed from the line.

Axiomatic Design This approach provides a framework of principles that guide the design engineers of products, services or processes. The approach reduces the complexity of the design process. Its purpose is to make the human designer more creative by reducing the random search process, thereby minimizing the trial and errors that are made during the design process.

(*Continued*)

Balanced Production All operations or cells produce at the same cycle time. In a balanced system, the cell cycle time is less than takt time. When a manufacturing system/entity produces "exactly" (+ or –) what their customers demand, it is said to be "in balance." (Note: Takt Time is the measurement most often used to determine if a manufacturing plant is "balanced." If a product's Takt Time is "1 part every 30 seconds" and the manufacturer can only produce "1 part every 40 seconds" then there will be a shortfall and the plant is not "in balance" with its customers. Likewise, if a plant produces "1 part every 15 seconds" they are overproducing (see 7 wastes), and are not "in balance" with their customers.

Bar Graph Have bands positioned horizontally (bars) or vertically (columns) which, by their height or length, show variations in the magnitude of several measurements. The bars and columns may be multiple to show two or more related measurements in several situations.

Batch-and-Queue Producing more than one piece of an item and then moving those items forward to the next operation before that are all actually needed there. Thus, items need to wait in a queue.

Batch Manufacturing (a.k.a. Batch Processing) Producing lots or quantities of a product to achieve maximum "Economic Order Quantities" (EOQ). Although some products must be batched to maximize use of equipment with long cycle times, often batching is wrongly assumed to be more economical than single-piece production for various reasons. Often when large "batches" are the preferred operating mode, it is due to excessively long or difficult changeover practices. Improving changeover techniques through SMED implementation will generally minimizes lot or "batch" sizes, reduce finished goods inventory on-hand, allow for increased varieties of products that can be made more quickly, and ultimately lead to greater customer responsiveness.

Bell-Shaped Curve The shape of a normal distribution curve.

Benchmark A reference point where other items can be compared. It can be a location, a process, a measurement, or a result.

Benchmarking (BMKG) The process of measuring products, services, and practices against those of leading companies. Also used as a comparison tool used to determine the level of process, product, or other successes your company is experiencing when compared to similar companies with similar products or processes—typically competitors. Methods include tracking metrics such as: On-time Delivery, Defective Parts Per Million produced, wages paid, market share growth, and projections. Most successful companies use benchmarking to identify strengths and weaknesses as compared to competitors and make needed adjustments.

Best Practice A process or a method that is superior to all other known methods.

Best-Value-Future-State Solution	A solution that results in the most beneficial new item as viewed by the item's stakeholders. It is the best combination of implementation cost, implementation cycle time, risk, and performance results (examples: return-on-investment, customer satisfaction, market share, risk, value-added per employee, time to implement, and cost to implement).
Blitz (See Kaizen Blitz)	A blitz is a fast and focused process for improving some component of business—a product line, a machine, or a process. It uses a cross-functional team of employees for a quick problem-solving exercise, where they focus on designing solutions to meet some well-defined goals.
Block Diagrams	A pictorial method of showing activity flow through a process, using rectangles connected by a line with an arrow at the end of the line indicating direction of flow. A short phrase describing the activity is recorded in each rectangle.
Bottleneck	Any resource whose capacity is equal to or less than the demand placed on it. The slowest operation (choke point) in a manufacturing process; not to be confused with a company's "constraint" taken from TOC (Theory of Constraints), which is the slowest operation in an entire manufacturing system that, if remedied, would increase overall company throughput.
Brainstorming	A technique used by a group to quickly generate large lists of ideas, problems, or issues. The emphasis is on quantity of ideas, not quality.
Budget	Provides the resources required to implement the tactics.
Bump-Back	Helping the person(s) before or after another person in a manufacturing cell or system. If one operation is a little faster than that of the person before who supplies the work, in some cases, we can finish part of their process so that the operator will continue to have parts to work on. If too much Bump-Back work is happening, it may be that you should re-evaluate the tasks undertaken at each work station in the cell.
Business Case Development	An evaluation of the potential impact a problem has on the organization to determine if it is worthwhile investing the resources to correct the problem or take advantage of the opportunity.
Business Objective	Defines what the organization wishes to accomplish over the next 5–10 years.
Business Plan	A communication, planning, and business system that reaches and involves every employee in support of common goals and objectives. It is a three-way interactive process that provides direction, expectations, and funding. It also defines the activities required to meet the agreed upon expectations. It includes the following 11 outputs: • Direction 1. Visions 2. Mission

(*Continued*)

3. Values
4. Strategic Focus
5. Critical Success Factors

- Expectation
6. Business Objective
7. Performance Goals

- Action
8. Strategies
9. Tactics
10. Performance Plans
11. Budget

Business Process Improvement (BPI) This is a breakthrough methodology that includes process redesign, process reengineering, process benchmarking, and fast action solution teams.

Calibration Comparing an instrument or measurement equipment performance to a standard of known accuracy. Normally, the standards are traced back to the National Bureau of Standards.

Capability The maximum achievable results that can be attained in a manufacturing system based on limitations imposed. Example: McDonald's could not build a complete aircraft carrier in its kitchen, but it could create a fine "Big-Mack." Size, weight, complexity of parts, environmental regulations, and processes (to name a few) all figure in to determining the capability of a manufacturing system.

Capacity The maximum amount a process, machine, or system can produce. If a machine is running "at capacity" it is going as fast as it can go and producing as much as it can produce. If a machine is running "below capacity" it is able to do more than it is currently doing. It is sometimes not necessary or desirable to run machines "at capacity." Most cars will exceed 100 miles per hour, but that excess capacity is typically not needed or advisable.

Capacity Constraint Resources Where a series of non-bottlenecks, based on the sequence in which they perform their jobs can act as a constraint.

Catch-Ball A series of discussions between managers and their employees during which data, ideas, and analysis are thrown like a ball. This opens productive dialogue throughout the entire company.

Cause-and-Effect Diagram A visual presentation of possible causes of a specific problem or condition. The effect is listed on the right-hand side and the causes take the shape of fish bones. This is the reason it is sometimes called a "Fishbone Diagram." It is also called "Ishikawa Diagram."

Cells The layout of machines of different types performing different operations in a tight sequence, typically in a U-shape, to permit single-piece flow and flexible deployment of human effort.

Cellular Manufacturing	(a.k.a. U-shaped cells, Work Cells) Generally, a horseshoe or U-shaped work area layout that enables workers to easily move from one process to another in close proximity and pass parts between workers with little effort. "Cells" typically focus on the production of specific models in "part families" but can be adjusted to many different products as needed. Work Cells do not need to be in a U-shaped configuration though this is often common due to maximizing product throughput with minimal use of space. We have created Work Cells in many different configurations that resemble letters such as S, T, W, X, and V; it is also common to create polygons, circles, rectangles, and so on. The ultimate layout of the cell is determined by the needs of the product. The goal in laying out a new Work Cell is to pass a part through every needed process with the minimal amount of wasted motion and distance. On the next level, the layout of the Work Cell is determined by the manual and machine cycle times and "Takt Time" to determine Cell staffing. Other issues when creating cells include redundancy of equipment, size of equipment needed, cure times, and Cell mobility/flexibility to accommodate multiple products. Effective Work Cell design often results in staff that moves between two or more stations to complete tasks required to meet the product demand rate.
Chaku-Chaku	A method of conducting single-piece flow, where the operator proceeds from machine to machine, taking the part from one machine and loading it into the next.
Change Agent	The catalytic force moving firms and value streams out of the world of inward-looking batch-and-queue.
Changeovers	Switching from producing one part/product to another is generally known as a changeover. This switching or changeover process may involve removing and replacing dies from machine beds, removing and replacing unused materials such as changing from corn to wheat in a food hopper, black plastic to white plastic in an injection molding bin, and so on. In Lean Manufacturing terms, changeovers are best accomplished through SMED (Single-Minute Exchange of Die), which strives to complete a changeover in less than 10 minutes or less. Also, it can involve the installation of a new type of tool in a metal working machine, a different paint in a painting system, a new plastic resin and new mold in an injection molding machine, new software in a computer, and so on.
Check Sheet	A simple form on which data are recorded in a uniform manner. The forms are used to minimize the risk of errors and to facilitate the organized collection and analysis of data.
Collecting Data	A systematic way of acquiring information about a specific point of interest.

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Co-Location Physically locating personnel and product lines in a single area thereby enabling rapid and constant communication among the key personal responsible for those products. Many companies now co-locate sales, customer service, engineering, administrative, production, and other functions in an attempt to create a fairly independent and full-service department that focuses on a single product or product family. There are pros and cons to this approach as many redundant roles are common. The upside is that there is an expertise and almost “omniscient” awareness of customer needs and production status.

Common Cause A source of errors that is always present because it is part of the random variation in the process itself. These types of failures are normally traced back to the process, which only management can correct.

Communication Techniques The many processes that are available to deliver and send messages through an organization by various channels, such as e-mail, meetings, gossip, newsletters, and so on.

Comparative Analysis A systematic way of comparing an item to another item to identify improvement opportunities and/or gaps (It is the first three phases in the benchmarking process.)

Competitive Benchmarking A form of external benchmarking that requires investigating a competitor’s products, services, and processes. The most common way to do this is to purchase competitive products and services and analyze them to identify competitive advantages.

Conflict Resolution An approach to find a win-win solution when two or more parties are in disagreement with each other. Often, conflict resolution ends up with a compromise on the position each party took in the original conditions.

Consensus An interactive process, involving all group members, where ideas are openly exchanged and discussed until all group members accept and support a decision, even though some of the groups’ members may not completely agree with it. To reach a consensus is time consuming and often involves individual compromising.

Constraint Anything that limits a system from achieving higher performance, or throughput. Taken from “Theory of Constraints” (TOC). A constraint is anything that limits a system from achieving higher performance relative to its goal. In practical application, a “Company’s constraint” is the biggest limiting factor that reduces the amount of throughput the company can achieve. This may mean a machine or process that is the slowest operation (bar none). A company can have many bottlenecks, but to be the constraint of the company, it must be the “Alpha Bottleneck” that affects the throughput of the company as a whole. Some companies have more than one constraint. Although one may be slightly larger than another, working to “break” two or three constraints of approximately the same size or limiting nature simultaneously is a worthwhile pursuit.

Continuous Flow Manufacturing (CFM)	This is a manufacturing system that is set up where there is no buffer between individual activities. The product is continuously moving without going into a storage area.
Continuous Improvement	The ongoing process/philosophy of doing things better, faster, and cheaper. A Lean Manufacturing system or organization will usually effect many large-scale and far-reaching changes while implementing Lean as a company directive. After the big "bang for the buck" Lean tools have been implemented there can be a tendency toward complacency. A structured Continuous Improvement process enables an organization to refine and enhance the benefits they now enjoy as a Lean company through usually small and incremental changes within the system. Example: stamping press #8 typically produces 27 parts per minute (ppm) but "Takt Time" tells us we now need 30 ppm. The press is already running "at capacity" so a decision must be made to purchase a similar press or somehow get 3 ppm more out of press #8. Using a Continuous Improvement Process, a Kaizen Team would carefully examine the possibility of getting more production out of the machine before buying another one. Perhaps, replacing worn belts, hydraulic pumps, regulators, shortening the "stroke" of the machine, or any number of other fixes would improve the machine enough to avoid buying a new one to meet current demand.
Controllable Poor-Quality Costs	These are the costs that management has direct control over to ensure that only acceptable products and services are delivered to the customer. It is divided into two subcategories: prevention costs and non-value-added costs.
Corrective Action	This is action that is taken to prevent reoccurrence of a problem. It is usually taken when an error/nonconformity is detected that warrants expending effort and money to prevent it from reoccurring.
Cost Driver	Any factor that causes a change in cost of an activity.
Cost of Quality	This was a process developed by Val Feigenbaum when he was quality director at a General Electric Division in the 1950s and put all the quality-related activities into a single cost base that could be added together. It was made up of four parts: Prevention Costs, Internal Defect Costs, External Defect Costs, and Appraisal Costs.
Creative Thinking	A methodology designed to stimulate and encourage creativity and innovation within an organization and individuals.
Creativity	Developing new or different ideas.

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Critical Path Methodology This is normally used with a project work breakdown structure where there is one path through the complex process that determines when the process is completed. By identifying this path, the project manager can focus on ensuring that cycle time and cost are optimized, thereby minimizing the risk of not completing the budget on time and on schedule.

Critical to Quality (CTQ) These are key measurable characteristics of a product or a process that are set to ensure customer satisfaction. They help ensure that the improvement activities are in line with the customer requirements. These customers can be either internal or external customers.

Cultural Roadblocks Each organization had its own set of acceptable and unacceptable behavioral patterns. Cultural roadblocks are those unacceptable behavioral patterns that will have a negative impact on completing a project.

Current State Maps Taken from Value Stream mapping (VSM), the "Current State Map" shows the value stream or process map as it is operating right now. Very often, the Current State Map will illustrate significant differences between how things are in reality and the documented processes and procedures. They help visualize the current production process and identify sources of waste. They are typically used to identify where in a process the 8 Wastes are present. The Current State Map is used as a springboard for creating an "Ideal State Map," which (with significant improvements) removes wasteful practices from the value stream.

Customer Requirements These are stated or implied terms that the customer requires to be provided with in order for him or her not to be dissatisfied.

Customer Surveys Obtaining customers' opinions related to the service or products supplied. This can be done in many ways including phone calls, written surveys, focus groups, one-on-one meetings, and so on.

Customer-Dissatisfaction Poor Quality Costs These are the lost profits because customers buy competitive products because they perceive that the competitor's product is better quality or because the customer has had or knows someone that has had an unsatisfactory experience with the organization.

Customer-Incurred Poor Quality Costs These are the costs that the customer incurs when a product or service fails to perform to the customer's expectations. Example: loss of productivity while equipment is down or travel costs and time spent to return defective merchandise, and the repair cost after the warranty period.

Cycle Time	The time required to complete one cycle of an operation. The time it takes to do one repetition of any particular task typically measured from "Start to Start" the starting point of one product's processing in a specified machine or operation until the start of another similar product's processing in the same machine or process. Cycle time is commonly categorized into (a) Manual Cycle Time: The time loading, unloading, flipping/turning parts, adding components to parts while still in the same machine/process, and so on. (b) Machine Cycle Time: The processing time of the machine working on a part. (c) Auto Cycle Time: The time a machine runs unaided (automatically) without manual intervention. (d) Overall Cycle Time: The complete time it takes to produce a single unit. This term is generally used when speaking of a single machine or process. (e) Total Cycle Time: This includes all machines, processes, and classes of cycle time through which a product must pass to become a finished product. This is not Lead Time, but it does help in determining it. In most cases, it does not matter very much which form of cycle time is greatest. What does matter is that your "Total Cycle Time" is less than your "Takt Time."
Cycle Time Analysis	An approach to reduce the time that it takes to move an item through a process.
Demand Management	Prediction of the levels of weekly or monthly product activity over a specified time (generally about 2 years). MRP II systems seem to be at least in part responsible for encouraging this practice.
Design for Maintainability and Availability	This is a methodology and tool set that is directed at analyzing the maintenance of a product to minimize the time to repair it and to maximize its total reliability. The object here is to minimize downtime. Often, it involves modular replacement rather than individual component replacement.
Design for Manufacturing and Assembly (DFMA)	This is a methodology that is used to determine how to design a product for ease of manufacturing. It is usually done by performing concurrent engineering, where manufacturing engineering develops the manufacturing process along with the design.
Direct Poor Quality Costs	These are costs that can be identified in the organization's ledger.
Discrete Data	Discrete data is based on count. It cannot be broken down into subdivisions. For example, it is the number of customer complaints that are received per week. It is also referred to as *Qualitative Data.*
Effectiveness	The extent to which an output of a process or subprocess meets the needs and expectations of its customers. A synonym for effectiveness is quality. Effectiveness is having the right output at the right place at the right time at the right price. Effectiveness impacts the customer.

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Efficiency The extent to which resources are minimized and waste is eliminated in the pursuit of effectiveness. Productivity is a measure of efficiency.

Equipment Certification This is an evaluation of each piece of equipment to define its accuracy, repeatability, drift, and capabilities so that it can be matched to the product specifications.

Equipment Poor-Quality Costs This is the cost invested in equipment used to measure, accept, or control the products or services, plus the cost of the space the equipment occupies and its maintenance costs. This category also includes any costs related to preparing software to control and operate the equipment.

Error Proofing Lean tool for making products correctly the first time, designing a potential failure or cause of failure out of a product or process. When thoroughly implemented, Error & Mistake-Proofing create improvements on many different levels. Even the products themselves may be redesigned to minimize errors in their manufacture. Tooling and processes are often reworked to produce error-free parts or at minimum catch errors before they become significant defects that require rework or become scrap. There are many common every day examples of mistake proofing; microwave ovens will not start with the door open; autos that automatically shut off lights at a predetermined time if you forget to turn them off when you shut off your car, medications sold in exact dosage packages, etc.

Establish the Burning Platform Define why the as-is-process needs to be changed and prepare a vision that defines how the as-is pain will be lessened by the future-state solution.

External and Internal Customers All organizations have internal and external customers. The output from any activity within an organization that goes to another individual within the organization has created an internal customer–supplier relationship. The person who receives the input is the internal customer. External customers are individuals or organizations that are not part of the organization that is producing the product. They typically buy the product for themselves or for distribution.

External Set-Up Steps and procedures that can be performed while a machine is still operating that facilitate the SMED (Single-Minute Exchange of Die) process. The most powerful technique used in many SMED applications is converting all "Internal Setup" (procedures that can only be completed while a machine is not operating) to "External Setup" procedures. Typically this one step will reduce setup/changeover times by + or –50%!

Facilitation of Teams This is an individual who is assigned to work with the team to make the meetings run more effectively. They work to ensure that the team functions correctly, not to participate in solving the problem.

First-Time Yield (FTY) This is the number of good parts that go into an operation divided by the number of acceptable parts going out of the operation without any rework. First-time yield for a total process is calculated by multiplying the first-time yield at each activity times the first-time yield at each activity in the process. It represents the number of parts that go through the process without being reworked or scrapped. It is also called Roll Through Yield (RTY).

Five "S's" or Five Pillars A system designed to bring organization to the workplace. A translation of the original 5S terms from Japanese to English went like this

- Seiri—Organization
- Seiton—Orderliness
- Seiso—Cleanliness
- Seiketsu—Standardized Cleanup
- Shitsuke—Discipline

To assist users of this tool to remember the elements the original terminology has been retranslated to the following 5Ss.

- Sort
- Set in Order
- Shine
- Standardize
- Sustain

Five Whys (5 Ws) This is a technique to get to the root cause of the problem. It is the practice of asking five times or more why the failure has occurred to get to the root cause. Each time an answer is given, you ask why that particular condition occurred.

Flexible Manufacturing A manufacturing process/system designed so that production areas (such as work cells or lines) can be changed and rebalanced often to adjust labor and materials to better meet and match demand. In a manufacturing cell, we often use reversible supply racks and alternate hanging tools that could be immediately used when the cell would convert from one product line (brand) to another.

Flow A main objective of the lean production effort, and one of the important concepts that passed directly from Henry Ford to Toyota. Ford recognized that, ideally, production should flow continuously all the way from raw material to the customer and envisioned realizing that ideal through a production system that acted as one long conveyor.

Flowchart A method of graphically describing an existing process or a proposed new process by using simple symbols, lines, and words to pictorially display the sequence of activities in the process.

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FOCUS This is a synonym for

- Find a process to improve
- Organize an effort to work on improvement
- Clarify current knowledge of the process
- Understand process variation and capabilities
- Select a strategy for continuous improvement

This was developed by W. Edwards Deming and provides his model for improving processes. It was based on Shewhart's Plan, Do, Check, Act approach.

Focus Groups A group of people who have a common experience or interest is brought together where a discussion related to the item being analyzed takes place to define the group's opinion/suggestions related to the item being discussed.

Force Field Analysis A visual aid for pinpointing and analyzing elements that resist change (restraining forces) or push for change (driving forces). This technique helps drive improvement by developing plans to overcome the restrainers and make maximum use of the driving forces.

Functional Layout The non-Lean practice of grouping machines or activities by type of operation performed.

Function Diagrams A systematic way of graphically displaying detailed tasks related to broader objectives or detailed issues related to broader issues.

Future State Mapping This usually takes the form of a flow diagram or a simulation model where a proposed change is drawn out pictorially to better understand the process. In the case where a simulation model is developed, the process can be operated over a period based on the assumptions made in the simulation model to determine how effective it will operate.

Gantt Chart A Gantt chart is a bar chart laid on its side. It is typically used for conveying a project schedule. It is an effective way of identifying interrelationships between tasks and helping to define critical paths through a process or project.

Gap Analysis A gap analysis is used to compare a present item to a proposed item. It typically will compare efficiency and effectiveness measurements between one product to a competitor's product or one process to another process. It reveals the amount of improvement necessary to bring it in line with the process or product it is being compared to.

Gemba A Japanese term that means "Real Place" or "Where the action takes place." In Lean, we speak of GEMBA as being the place where "value" is added to a product. In the most practical sense, Lean attempts to make everything in a factory Gemba, or a value adding process or location. The antonym of Gemba is Muda, or "Waste" which Lean practitioners do all in their power to eliminate.

Graphs	Visual displays of quantitative data. They visually summarize a set of numbers or statistics.
Group	Individuals who are gathered together for administrative purposes only. Individuals work independently, sometimes at cross purposes with others in the group.
Group Technology	Group Technology separates parts into "Families" or groups that have similar needs with respect to manufacturing processes. Parts may be "grouped" by size weight, color, flavor, chemistry, treatments/special processing needed, and so on. Creating "Part Families" or "Groups" can result in lower inventories, reduced consumption of process resources, and many other benefits. On an intuitive level and for the purpose of identifying and exposing the "Value Stream," grouping parts into "families" can help to identify further improvement opportunities.
Hard Consensus	When all members of the team absolutely agree with the outcome or solution.
Heijunka Box	A method of leveling production at the final assembly line that makes just-in-time production possible. This involves averaging both the volume and sequence of different model types on a mixed-model production line.
Histograms	A visual representation of the spread or distribution. It is represented by a series of rectangles or "bars" of equal class sizes or width. The height of the "bars" indicates the relative number of data points in each class.
Hoshin Kanri	This in an annual planning process that is used to develop the Hoshin plan or policy development. It is used to set the direction of the improvement activities within the organization. Hoshin is made up of two Chinese words: *Ho*, which means method or form, and *Shin*, which means shiny needle or compass. *Kanri* means control or management. It is a very systematic, step-by-step planning process that breaks down strategic objectives against daily management tasks and activities.
Independent Variable	An independent variable is an input or process variable that can be set directly to achieve a desired result. A variable that we control during an experiment.
Indirect Cost	These are the costs that are imposed on an output that is not directly related to the cost of the incoming materials or the activities that transform it into an output. It is all the support costs that are needed to run the business that are applied against the product in order to make a profit. For example, the cost of accounting, personnel, and ground maintenance.
Indirect Poor Quality Costs	Costs that are incurred by the customer or costs that result from the negative impact poor quality has on future business, or lost opportunity costs.

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Initiating Sponsor Individual/group who has the power to initiate and legitimize the change for all of the affected individuals.

Innovation Creating something new, that is, an idea, device, or processing method—Invention. Identified by Ideation International as the "8th Waste" in "Ohno's 7 Wastes of Manufacturing," it recognizes that the potential for innovation available in every workforce goes largely unrealized.

Intangible Benefits These benefits are gains attributed to an improvement project that are not documented in the formal accounting process. They are often called "soft benefits." Frequently, they are savings that result from preventive action that stops errors from occurring.

Internal Error Costs The costs incurred by the organization as a result of errors detected before the organization's customer accepts the output. In other words, it is the cost the organization incurs before a product or service is accepted by the customer because someone did not do the job right the first time.

Internal Set-up Taken from SMED, these are set-up procedures that can only be affected when a machine is in a "Zero Mechanical State." The goal of SMED is to change dies or other components/processes in less than 10 minutes. Internal Setup elements that require machines to be completely inoperable are one of the greatest sources of waste during a setup/changeover process. Therefore, much time and attention is dedicated to discovering how machines can continue running during most or all of the changeover process. If a SMED Kaizen Team can make Internal Setup procedures "External," then they will generally reduce setup/changeover times by at least 50%.

Interviewing A structured discussion with one or more other people to collect information related to a specific subject.

Inventory The money and materials invested in by a company to create products for sale. In reality, there are few areas that can yield more outstanding initial cost savings than the reduction of inventory in many, if not most companies. Inventory must be viewed as "MONEY" and treated accordingly. The most common types of inventory are (a) raw materials: un processed components waiting for work to be done on them, and is the least expensive form of inventory, especially if suppliers will wait for payment until you begin using these materials; (b) work in process (W.I.P.): materials that have had some work done to them but are not yet finished. This is the second most expensive form of inventory as "value" has been added to the materials; and (c) finished goods: this is the most expensive type of inventory as the materials have already traveled through the value stream and are now complete. Although most companies carry some finished goods inventory, it can be a serious waste and burden on cash-flow.

Inventory Turnover Rate The number of times an inventory cycles or turns over during the year. A frequently used method to compute inventory turnover is to divide average inventory level into annual cost of sales. The number of times you can "Turn" (use and replace) your inventory/money over in a year. For example, if your company holds $1000 worth of inventory every month and consumes $1000 worth of inventory every month, it would equal "12 Inventory Turns per year." The real world is not as clean as the example above, and it can be challenging to know how many times each year you "turn" your inventory. Some companies will speak of inventory turns specific to individual parts or materials, that is, "We turn our raw widget parts every week," or "we have 24 turns a year on our coiled steel." The Lean message behind inventory turns is to keep enough inventory on-hand to satisfy your customers but not so much that it winds up collecting dust and costing you money in the form of lost interest, damage, obsolescence, storage space, moving it around, and so on.

Hoshin Planning (HP) Also known as Management by Policy or Strategy Deployment. A means by which goals are established and measures are created to ensure progress toward those goals. HP keeps activities at all levels of the company aligned with its overarching strategic plans. HP typically begins with the "visioning process" which addresses the key questions: Where do you want to be in the future? How do you want to get there? When do you want to achieve your goal? And who will be involved in achieving the goals? HP then systematically explodes the what's, who's, and how's throughout the entire organization.

Just-in-Time (JIT) Principles that are fundamental to time-based competition, waste elimination, process simplification, set-up and batch-size reduction, parallel processing, and layout redesign are critical skills in every facet of the lean organization. JIT is a system for producing and delivering the right items at the right time, in the right amounts. A Lean Manufacturing process for synchronizing materials, operators, and equipment such that all materials and people are where they need to be, when they need to be there, and in the state they need to be there in. JIT is ultimately focused on reducing or eliminating every form of waste in the manufacturing process. Many Lean Manufacturing tools help to make achieving a just-in-time system possible. Example: It does not matter much if materials arrive at a machine for processing when the machine is "down" because of to poor maintenance. A TPM (Total Productive Maintenance) program could remedy this situation. Likewise, if it takes several hours to change-out dies materials could spend substantially more time waiting for processing than actually being processed. SMED efforts are warranted to enable quick changeovers and allow JIT methods to be effectively employed. The key elements of just-in-time are Flow, Pull, Standard Work, and Takt Time.

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Kaban A signaling device that gives instruction for production or conveyance of items in a pull system. Can also be used to perform kaizen by reducing the number of Kanban in circulation, which highlights line problems. Comes from a Japanese term meaning "visual record" or "card." In Lean Manufacturing, Kanban has come to mean signal. Kanban signals are basically just telling workers that there is more work to be done. In other words, the presence of a "Kanban Card" or an empty "Kanban Location" is a "signal" to do the work described on the card (make the parts) or fill the empty Kanban location with parts, which means you have to make them to put them there. There are many ways to use and implement Kanban, such as empty totes, pallets, cartons, flashing lights, and electronic messages. You can even park a semi truck at a certain dock and that could be your signal to produce parts that will be shipped via this truck. There is no limit to the creativity you can have with Kanban signals. One key is to make them work in your specific situation and environment. Perhaps the most important rule of Kanban is to "Obey Kanban." In other words, do not go around the system or it will fail. Failing to keep the rules of Kanban will result in higher inventories, greater risk for errors/defects, and other associated problems. Now that we have emphasized keeping the rules of Kanban, we must discuss a few reasonable exceptions. Breaking Kanban limits to production should occur if a machine has broken but will be able to catch up as soon as it is repaired. Yes, you will be building inventories, but this machine cycles faster than the feeding machine(s) and will be able to process the temporary glut of WIP (work in process) parts. One more exception might be breaking Kanban to create parts for a customer or sister company that suddenly and desperately needs parts that are only finished to a certain degree. You may find yourself off-loading a machine or process to feed temporary work cells to meet this unexpected and "temporary" demand.

Kaikaku Kaikaku is a transformation of mind. It completely encompasses one's approach to thinking about a process entirely from a Lean point of view. This is a revolutionary type of activity, while Kaizen is evolutionary. Kaikaku is a wholistic approach and in this respect is similar to process reengineering or redesign.

Kaizen This is a Japanese term that means continuous improvement. *Kai* means change and *zen* means good or for the better.

Kaizen Blitz This means a sudden, overpowering effort to take a process, system, product, or service apart and put it back together in a better way.

Kano Model This is a model that was created by Prof. Noriaki Kano, which classifies customer preferences into five categories. They are attractive, one-dimensional, must-be, indifferent, and reverse. The Kano model of customer satisfaction classifies product attributes based on how they are perceived by the customer and their effect on customer satisfaction. This model is useful in guiding the organization in determining when good is good enough and more is better.

Key Performance Indicators (KPI)	KPI stands for "key performance indicators." These measurements indicate the key performance parameters related to a process, organization, or output. They are the key ways by which that item is measured and are usually used to set performance standards and continuous improvement objectives. They are sometimes called CPI (critical performance indicators).
Knowledge Management	This is a system for capturing the knowledge that is contained within an organization. It groups knowledge into two categories. The first classification is tacit knowledge (soft knowledge). This knowledge is undocumented, intangible factors embodied in an individual's experience. The second classification is explicit knowledge (hard knowledge). This knowledge is documented and quantified.
Leader Standard Work	A defined set of standard practices completed by management. These typically include a regularly scheduled gemba walk to pre-selected processes to review standard practices in that area. Everyone in the organization that supervisor's people should have Leader Standard Work. Typical Standard Work Percentages of total work time – Operators = 95 + % – Supervisors = 90% – Department Managers = 20% – Senior Managers = 10%
Lead Time	The total time a customer must wait to receive a product after placing an order. When a scheduling and production system is running at or below capacity, the lead time and throughput time are the same. When demand exceeds the capacity of a system, there is additional waiting time before the start of scheduling and production, and lead time exceeds throughput time. Sometimes, the single biggest difference between competing companies is the amount of Lead-Time they will commit to. If company Alpha promises they will have your products delivered to your door in 6 weeks and company B promises a 1-week delivery, which company will you likely choose? Lean Manufacturing has many tools that ultimately reduce Lead-Time and win market share. Oddly enough Inventory in a manufacturing system has the limiting effect of increasing Lead-Time.
Lean	Lean is a business operational philosophy that results in business processes requiring less human effort, capital investment, floor space, materials, and time in all aspects of operation.

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Lean Accounting A method of accounting that is aligned horizontally across your organization with the value stream. Traditional costing structures can be a significant obstacle to Lean Six-Sigma deployment. A Value Stream Costing methodology simplifies the accounting process to give everyone real information in a basic understandable format. By isolating all fixed costs along with direct labor, we can easily apply manufacturing resources as a value per square footage utilized by a particular cell or value stream. This methodology of factoring gives a true picture of cellular consumption to value-added throughput for each value stream company wide. Now you can easily focus improvement kaizen events where actual problems exist for faster calculated benefits and sustainability.

Lean Enterprise An organization that is engaged in the endless pursuit of waste elimination in all of its activities. Lean Enterprise focuses on all aspects of a company's system, whereas Lean Manufacturing tends to focus on production activities. Lean Enterprises are diligently working to reduce waste in all of its many forms in every department and activity the organization engages in. Lean Enterprises reduce or eliminate paperwork, improve supply chain agreements, enhance hiring and training processes, provide employee development opportunities, and many other such activities.

Lean Manufacturing Lean Manufacturing is an operational philosophy focused on eliminating all waste in the manufacturing process. It includes lean concepts such as

Zero inventory
Batch to flow, cutting batch size
Line balancing
Zero wait time
Pull instead of push production control systems
Cutting actual process time

It can also be described as a manufacturing/production system best characterized as relentlessly eliminating waste from all of its activities and operations. Lean strives to produce products: on-time, using as few resources as possible, better than competitors, faster and cheaper than competitors, and so on. Lean Manufacturing is the "umbrella" under which many manufacturing improvement tools are housed. Some examples include (a) SMED, Single-Minute Exchange of DIE; (b) TPM, Total Productive Maintenance; (c) 5S, Visual Workplace or Visual Factory; (d) Kanban, Work Signaling System; (e) Two-Bin, Materials Replenishment system; (f) Error and Mistake-Proofing, A perfect process tool; (g) Level-Loading (Heijunka), For producing mixed quantities and styles of products; and others. Lean Manufacturing is now present throughout the world and has become a global standard or set of practices that virtually all companies must adopt to be competitive in a global economy. Beyond the "need" to compete globally, Lean empowers and motivates employees to engage in the betterment of their respective companies.

Lean Metric Lean metrics allow companies to measure evaluate and respond to their performance in a balanced way, without sacrificing the quality to meet quantity objectives, or increasing inventory levels to achieve machine efficiencies. The type of the Lean metric depends on the organization and can be of following categories: Financial performance, behavioral performance, and core process performance.

Lean Supply Chain The process of extending your Lean Six-Sigma activities to your supply chain by partnering with suppliers to adopt one or more of the Lean Concepts or Tools.

Lean Thinking This is a focus on eliminating all waste within the processes, including customer relations, product design, supplier networks, production management, sales, and marketing. Its objective is to reduce human effort, inventory, cycle time, and space required to produce customer-deliverable outputs.

Level-Loading A technique used to balance production throughput according to the needs of customers (demand). Level-Loading is loading your production system according to the exact needs (+ or –) of your customers. Ideally, it is based on the consumption of products customers are "pulling" from your system. Mixed-Level-Loading supports the same concept as Level-Loading, which is to supply your customers with exactly what they need when they need it. However, "mixing" includes producing perhaps many different models of products in correct quantities and ratios to satisfy customer demand for a variety of products with shorter-than-average lead-times. Level and Mixed-Level Loading are advanced Lean methods and require a good deal of Lean implementation before they can be very successfully applied in "real-world" plants. You must have the ability to switch from one product to another very quickly (usually automatically) to make this system work. Often you will need to modify tooling to accept a variety of parts so that no changeover process is required at all. Example: One particular client of ours is an automotive OEM plant. They are so good at Mixed-Level-Loading that on one small conveyor you will often see two or three Toyota parts followed by one or two GM parts, followed by four or five Nissan parts, followed by two Toyota parts, followed by six or eight Ford parts, followed by…. Finding the right mix to satisfy each customer in real-time is much easier than being able to produce that mix. Putting all the best Lean tools in place will enable you to eventually take your production to this pinnacle level of performance.

Line Graph The simplest graph to prepare and use is the line graph. It shows the relationship of one measurement to another over a period. Often, this graph is continually created as measurement occurs. This procedure may allow the line graph to serve as a basis for projecting future relationships of the variables being measured.

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Manufacturing Execution Systems A networked computing system used to automate production control and process automation through intercommunication between production scheduling, work scheduling, and production throughput to bridge gaps that might appear between these functions.

Milestone Graph Shows the goals or target to be achieved by depicting the projected schedule of the process. A primary purpose is to help organize projects and to coordinate activities.

Mind Maps A mind map is an effective tool to capture and make your thoughts visible. It allows a one or more people to reach out from main thoughts to a range of avenues connected to the main thought. It can be used in a range of situations, such as brain storming; problem solving; and project definition. It is an outstanding tool for creativity, and innovation in a change management environment.

Mistake Proofing Any change to an operation that helps the operator reduce or eliminate mistakes.

Mura Any process variation that is inconsistent or irregular. Mura is present when workload is out of balance or when workflow is inconsistent or not standard.

Muri Any task that requires unreasonable stress or effort from personnel, material, or equipment. For people, this could represent a task that is too physical. For machinery, this could be expecting a machine to do more than it is capable of or has been designed to do.

Muda Anything that interrupts the flow of products and services through the value stream and out to the customer is designated Muda or waste.

No-Value Added Activities or actions taken that add no real value to the product or service making such activities or action a form of waste. This amounts to any process or event that does not make a product more like what a customer is willing to pay for. This is a very simple definition but has far reaching implications. Lean Manufacturing is almost completely about removing waste from manufacturing and processes. Waste is best defined as "any process that does not add value to a product." To appreciate the definition of Non-Value Added (NVA), we need to revisit the concept of "VA" or "Value-Adding," which states that "Value-Adding" activities are "Any activity that makes a product more like what a customer is willing to pay for." No customers want to pay for activities that do not "add value" to their products. The fact is all customers indirectly pay for Non-Value-Adding activities because suppliers build them into the sales price of everything they produce.

No-Value-Added Costs	These are the costs of doing activities that the customer would not want to pay for because it adds no direct value to him or her. It can be further divided into business-value-added, no-value-added, and bureaucracy costs. It also includes appraisal costs.
One-Piece Flow	This is a concept where a single piece of work moves between work stations instead of a batch process.
Operating Expenses	The money required by the system to convert inventory into throughput.
Opportunities	It is anything within the product, process, service, or system that could cause an error that would make the output less than ideal in the customer's eyes. Opportunities are the things that must be right to satisfy the customer. They are not the number of things that could possibly go wrong within the process. For example, in typing a five-letter word, there are five opportunities for making an error that the customer would be dissatisfied with.
Organization Change Management	A methodology designed to lessen the stress and resistance of employees and management to individual critical changes.
Organizational Excellence	This methodology is made up of five key elements, called the *Five Pillars*, which must be managed simultaneously to continuously excel. The five pillars are Process Management Project Management Change Management Knowledge Management Resource Management
Overall Equipment Effectiveness	Measures the availability, performance efficiency, and quality rate of equipment; it is especially important to calculate OEE for the constrained operations. The Combined Measurement of Equipment Availability, Performance Rate, and Quality Rate: A key measurement in "Total Productive Maintenance" (TPM). Formula: Machine Availability × Performance Rate × Quality Rate; where machine availability is the actual time left for production after you subtract all planned downtime, performance rate is the measure of "how well the machine was running when it was running," and quality rate tells us how many good parts vs. defective parts a machine has produced during the time it was running. OEE is an essential measurement for determining the effectiveness of your equipment and beginning to understand where uptime improvements are possible.

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Overproduction Overproduction is making more, faster, or earlier than is required by the customer or next process step. Overproduction can lead to other wastes such as excess inventory, defects, motion, and transportation.

Pareto Diagrams A type of chart in which the bars are arranged in descending order from the left to the right. It is a way to highlight "the vital few" in contrast to "the trivial many."

Perfection Always optimizing value-added activities and eliminating waste

Performance Goals Quantifies the results that will be obtained if the business objectives are satisfactorily met.

Performance Improvement Plan (PIP) A plan designed to align the environment within an organization with a series of vision statements that drive different aspects of the organization's behaviors.

Performance Plan A contract between management and the employees that define the employees' roles in accomplishing the tactics, and the budget limitations that the employees have placed upon them.

Performance Standard Defines the acceptable error level of each individual in the organization.

PERT Charts PERT stands for Program Evaluation Review Technique. This is a methodology that was developed by the U.S. Government in the 1950s. It is a project management tool used to schedule, organize, and coordinate tasks within the project. It provides an effective way of determining interdependencies between activities and timing. It allows for the critical path through the project to be readily defined.

Pictorial graphs A way to represent data using pictures. Pictograms are a type of pictorial graph in which a symbol is used to represent a specific quantity of the item being plotted. The pictogram is constructed and used like bar and column graphs.

Plan-Do-Check-Act A structured approach for the improvement of services, products and/or processes developed by Walter Shewhart.

Plus Minus Interesting An idea evaluation weapon that analyzes the idea or concept by making a list of positive (+) and negative (–) things related to the idea or concept. It also uses a third column, called "interesting" where random thoughts about the item being evaluated are recorded. A technique often used to evaluate a solution that may initially seem like a bad idea.

Point-of-use-Storage (POUS) Locating materials, tools, all necessary accessories at the point of value adding activities.

Poka-Yoke A mistake-proofing device or procedure to prevent a defect during order taking or manufacture. These are typically devices that are low cost, prevent reoccurrence, simple to implement, use, and maintain.

Poor-Quality Cost (PQC) This was an improvement on the quality cost system developed in the 1950s by Val Feigenbaum at General Electric. It extended the concept from direct quality cost to direct and indirect quality cost. It contains the following categories:

1. Direct Poor-Quality Cost
   a. Controllable Poor-Quality Cost
      i. Preventive Cost
      ii. Appraisal Cost
      iii. No-Value Added Cost
   b. Resultant Poor-Quality Cost
      i. Internal Error Cost
      ii. External Error Cost
      iii. Equipment Poor-Quality Cost
2. Indirect Poor-Quality Cost
   a. Customer Incurred Cost
   b. Customer Dissatisfaction Cost
   c. Loss of Reputation Cost
   d. Lost Opportunity Cost

It is a methodology that defines and collects costs related to resources that are wasted as a result of the organization's inability to do everything correct every time. It includes both direct and indirect costs.

Prevention Costs These are all the costs expended to prevent errors from being made or, to say it another way, all the costs involved in helping the employee do the job right every time.

Preventive Action This is action taken that will eliminate the possibility of errors occurring rather than reacting from errors that occurred. It is a long-term, risk-weighted action that prevents problems from occurring based on a detailed understanding of the output and/or the processes that are used to create it. It addresses inadequate conditions that may produce errors.

Process A series of interrelated activities or tasks that take an input and provide an output.

Process Benchmarking A systematic way to identify superior processes and practices that are adopted or adapted to a process to reduce cost, decrease cycle time, cut inventory, and provide greater satisfaction to the internal and external customers.

Process Control Process control encompasses all activities required to ensure that a process in stable, predictable, and results in a targeted level of performance. Process controls can be engineered into the process or be achieved via standard operating procedures or total productive maintenance programs.

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Process Elements These are the subunits that make up a process. They are normally referred to as activities, and the subunits to the activities are tasks.

Process Flow Animation A process model that shows the movement of transactions within the process and how outside functions impact the performance of the process.

Process Kaizen Improvements made at an individual process or in a specific area. Sometimes called "point kaizen."

Process Improvement Team A group of employees assigned to improve a process. It is usually made up of employees from different departments.

Process Owner The individual responsible for the process design and performance. They are responsible for the overall performance from the start of the process to the satisfaction of the customer with the delivered output. It is the responsibility of the process owner to ensure that suboptimization does not occur throughout the process as well as setting improvement performance goals for the process.

Process Performance Analysis The collection of performance data (efficiency and effectiveness data) at the activities or task level of a flowchart that is used to calculate the performance of the total process.

Process Performance Matrix This is the efficiency, effectiveness, and adaptability measurements related to the process. Particular focus is paid to the effectiveness measurements because they need to reflect customer requirements.

Process Qualification A systematic approach to evaluating a process to determine if it is ready to ship its output to an internal or external customer.

Process Redesign A methodology used to streamline a current process with the objective of reducing cost and cycle time by 30%–60% while improving output quality from 20% to 200%.

Process Reengineering This is a radical methodology that challenges all the paradigms that the organization has imposed on the process. It is usually used when the present process is so obsolete or so bad that you do not want to influence the new process in the design concept. Typically, a process reengineering project takes 6 to 9 months to complete and is used when cost and cycle time need to be reduced by more than 60%.

Process Route Table Shows what machines and equipment are needed for processing a component or assembly. These tables aid in creating ordinary lines and grouping work pieces into work cells.

Process Simplication A methodology that takes complex tasks, activities, and processes and bisects them to define less complex ways of accomplishing the defined results.

Process Simulation A technique that pictorially processes resources, products, and services in a dynamic computer model.

Processing Time The time a product is actually being worked on in a machine or work area.

Project Champion This is the individual who makes sure that the project has the resources and cross-functional support that is needed to be successful. The project champion is the individual that is most accountable to the executive team for the overall results of the project.

Project Communications Management A subset of project management that includes the processes required to ensure timely and appropriate generation, collection, dissemination, storage, and ultimate disposition of project information.

Project Cost Management A subset of project management that includes the processes required to ensure that the project is completed within the approved budget.

Project Financial Benefit Analysis This is an analysis that is conducted at least at each checkpoint in the process. It evaluates the potential savings compared to the cost of making the change. Early in the project, both potential savings and cost are estimated. When the project has been implemented, actual project financial benefit analysis figures can be provided.

Project Human Resource Management A subset of project management that includes the processes required to make the most effective use of the people involved with the project.

Project Integration Management A subset of project management that includes the processes required to ensure that the various elements of the project are properly coordinated.

Project Management The application of knowledge, skill, tools, and techniques to project activities to meet or exceed stakeholders' needs and expectations from the project. It includes the following:

- Project Integration Management
- Project Scope Management
- Project Time Management
- Project Financial/Cost Management
- Project Quality Management
- Project Resource Management
- Project Communication Management
- Project Risk Management
- Project Procurement Management
- Project Organizational Change Management
- Project Document/Configuration Management
- Project Planning and Estimating Management

This is a primary responsibility of the Master Black Belts, Black Belts, and Green Belts.

Project Quality Management A subset of project management that includes the processes required to ensure that the project will satisfy the needs for which it was undertaken.

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Project Risk Management A subset of project management that includes the processes concerned with identifying, analyzing, and responding to project risk.

Project Scope This defines the boundaries within which the project will work and it helps prevent project creep.

Project Scope Management A subset of project management that includes the processes required to ensure that the project includes all the work required, and only the work required, to complete the project successfully.

Project Selection Matrix This is a matrix that analyzes the various improvement opportunities to define the ones that should be approved or continued. A number of factors need to be considered. Typical factors are

- Impact on a customer
- In line with the strategic objectives
- Financial returns
- Competitive advantage

Project Time Management A subset of project management that includes the processes required to ensure timely completion of the project.

Pull A system of cascading production and delivery instructions from downstream to upstream activities in which the upstream supplier waits until the downstream customer signals a need. A pull system means producing only what has been consumed by downstream activities or customers.

Pull System This is a production control system that replaces parts and components only when the same part or component has been consumed. It is designed to eliminate in-process storage and is part of a just-in-time system.

Push System In contrast to the pull system, product is pushed into a process, regardless of whether it is needed. The pushed product goes into inventory, and lacking a pull signal from the customer indicating that it has been bought; more of the same product could be overproduced and put in inventory.

Qualification Acceptable performance of a complete process consisting of many operations that have already been individually certified. For a process to be qualified, each of the operations and all of the equipment used in the process must be certified. In addition, the process must have demonstrated that it can repeatedly produce high-quality products or services that meet specifications.

Qualitative Data It is data related to counting the number of items and cannot be broken down into smaller intervals. It is count rather than measurement data. For example, the number of machines shipped in a specific time.

Quality @ Source	Building Quality into value-adding processes as they are completed. This is in contrast to trying to "inspect in quality," that only catches mistakes after they have been made. An effective Quality @ Source campaign can minimize or eliminate much of the expense associated with traditional Quality Assurance and Control programs.
Quality Management	All activities of the overall management function that determine the quality policy, objectives, and responsibilities and implement them by means such as quality planning, quality control, quality assurance, and quality improvement within the QMS (ISO 8402).
Quality Management System/ISO 9000 (QMS)	The organizational structure, procedures, processes, and resources required to determine the quality policy, objectives, planning, control, assurance, and improvement that impact, directly or indirectly, the products or services provided by the organization.
Quality Manual	A document stating the quality policy and describing the QMS of an organization (ISO 8402).
Quality Plan	A document setting out the specific quality practices, resources, and sequence of activities relevant to a particular product, project, or contract (ISO 8402).
Quality System	The organizational structure, procedures, processes, and resources needed to implement quality management (ISO 8402).
Quick Changeover	The ability to change tooling and fixtures rapidly (usually minutes), so multiple products can be run on the same machine. Quick changeover is a technique to analyze and reduce resources needed for equipment setup, including exchange of tools and dies. Single-Minute Exchange of Dies (SMED) is an approach to reduce output and quality losses due to changeovers.
Queue Time	The time a product spends in a line awaiting the next design, order processing, or fabrication step.
Rapid Prototyping	A process that avoids creating conventional tooling thereby limiting investment expense while new parts or products are tested for feasibility of manufacture. This is a very exciting area for improvements in manufacturing generally. Some Rapid Prototyping software and devices are maturing to the point where it is starting to become possible in the near future that we will be telling computers to "make a baseball" or "make a fuel injection system." Many experts expect Rapid Prototyping to evolve into Rapid Creation, and the face of many industries will be changing significantly as this technology develops.
Reliability Management System	Designing, analyzing, and controlling the design and manufacturing processes so that there is a high probability of an item performing its function under stated conditions for a specific period.

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Resultant Poor-Quality Costs These are the costs that result from errors. These costs are called resultant costs because they are directly related to management decisions made in the Controllable Poor-Quality Costs category. It is divided into two subcategories: internal error costs and external error costs.

Rewards and Recognition This is action taken to reinforce desired behavior patterns or exceptional accomplishments. Categories of rewards and recognition are

- Financial compensation
- Monetary awards
- Group/team rewards
- Public personal recognition
- Private personal recognition
- Peer rewards
- Customer rewards
- Organizational awards

Risk Analysis This is an evaluation of the possibility of suffering harm or loss. A measure of uncertainty. An uncertain event or condition that, if it occurred, might have a positive or negative effect on the organization or the project.

Risk Assessment Performing a quantitative analysis of the risks and conditions to prioritize their effects on the project objectives or the organization's performance.

Robust Process A robust process operates at the Six Sigma level, producing very few defects even when the inputs to the process vary.

Robustness The characteristics of a process output and process design that make it insensitive to the variation in inputs.

Root Cause Analysis The process of identifying the various causes affecting a particular problem, process, or issue and determining the real reasons that caused the condition.

Run Charts A graphic display of data, used to assess the stability of a process over time, or over a sequence of events (such as the number of batches produced). The Run Chart is the simplest form of a Control Chart.

SDCA Standardize, Do Check Act cycle. This cycle is used standardized out of control processes. It is often the first set of activities in a process improvement program. SDCA is normally followed by the PDCA cycle.

Sensei An outside master or teacher who assists in implementing lean practices.

Seven Wastes Taiichi Ohno's original catalog of the wastes commonly found in physical production. These are overproduction ahead of demand, waiting for the next processing stop, unnecessary transport of materials, overprocessing of parts due to poor tool and product design, inventories more than the absolute minimum, unnecessary movement by employees during the course of their work, and production of defective parts.

SIPOC This stands for suppliers, inputs, processes, output, and customers. It is used to help you ensure that you remember all the factors when mapping a process.

SMED This stands for Single-Minute Exchange of Die. It is one of the lean tools and it is a key part of just-in-time programs. It is a methodology used to minimize the amount of time of changing a process over to produce another output.

SCAMPER This is a checklist and acronyms made up of the following:
S—Substitute
C—Combine
A—Adapt/Adopt
M—Modify/Magnify/Minify
P—Put to other Uses
E—Eliminate
R—Reverse/Rearrange
This technique is used to generate ideas when each of these questions is asked.

Shewhart Cycle (PDCA) The same as Plan-Do-Check-Act.

Single-Piece Flow A situation in which products proceed, one complete product at a time, through various operations in design, order taking, and production, without interruptions, backflows, or scrap.

Sigma This is a Greek letter and statisticians use it to refer to the standard deviation of a population. Sigma and standard deviation are interchangeable.

Simplification Approaches These are a series of techniques that focus on simplifying the way things are done. It could include things such as the following:

Combining similar activities
Reducing amount of handling
Eliminating unused data
Clarifying forms
Using simple English
Eliminating non-value-added activities
Evaluating present IT activities to determine if they are necessary
Evaluating present activities to determine if IT approaches would simplify the total operations

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Simulation Modeling Using computer programs to mimic the item (activity process or system) under study to predict how it will perform or to control how it is performing.

Six Sigma Six Sigma is a rigid, systematic methodology that uses information (managing by fact) and statistical analysis to measure and improve an organization's performance by identifying and preventing errors. It can be thought of in three parts:

1. Metric: 3.4 defects per million opportunities
2. Methodology: DMAIC/DFSS structured problem-solving tools
3. Philosophy: reduce variation in the organization and drive decisions based on knowledge of the customer

Six Sigma Matrix This is divided into four categories. They are

1. Measuring customer opinion
2. Determining customer critical-to-quality factors
3. Measuring product outcome
4. Correlate product outcomes to critical-to-quality factors (Measure processes with a matrix that correlates to the organization's economics)

Six-Sigma Program A program designed to reduce error rates to a maximum of 3.44 errors per million units, developed by Motorola in the late 1980s.

Six-Step Error-Prevention Cycle A process to prevent problems from occurring rather than fix them afterward.

Six-Step Problem-Solving Cycle A basic procedure for understanding a problem, correcting the problem, and analyzing the results.

Six-Step Solution-Identification Cycle A procedure for defining how to solve a problem or take advantage of an opportunity.

Soft Consensus When some members would prefer a different solution but are willing to support the decision of the team.

Soft Savings This is sometimes also referred to as intangible savings. It is the benefit you get from a change that is not directly reflected in the accounting system. It includes things such as reduced cycle time, cost avoidance, improved employee morale, lost-profit avoidance, and higher levels of customer satisfaction. The importance of soft savings cannot be over stated. In many instances, process improvements result in soft savings that latter become hard savings.

Spider Diagrams/Radar Charts Used to show or compare one or more sets of data to each other. Often used to indicate the status quo (current state) against the vision (future state).

Stakeholder Analysis Plan A system to identify "key stakeholders" or individuals that have a stake in the overall success/failure of the process.

Standard Deviation An estimate of the spread (dispersion) of the total population based on a sample of the population. Sigma (σ) is the Greek letter used to designate the estimated standard deviation.

Standard Work Repeating work activities using the same processes every time. Standardized Work will generally include testing work processes again and again to prove out the "Current best ways" of completing tasks. The "current best ways" is an important concept as one of the basic tenants of Standardized Work is that you are always looking for better ways to do work. Normally when we help companies implement Standardized Work, we use photos, simple diagrams, and plain text to make work instructions and present them in a very clear manner. It is difficult to get consistent quality and timely output unless you standardize work processes and write "Standardized Work Instructions" that must be followed. Most workers like to do things "their own way," and that is fine as long as their way is the standardized way. If workers wish to challenge the "Standardized Work Instructions" that is fine and even appreciated. The key is that everyone should be completing whatever task in the "Current Best Way."

Storyboard A series of pictures and accompanying narrative that is used to define how something is done or what is going on related to a problem or situation.

Strategy The approach that will be used to meet the performance goals

Structural Roadblocks These are obstacles that must be overcome for a process or an organization to transform from one state into another.

Suboptimization A condition where gains made in one activity are offset by losses in another activity or activities.

Supplier Controls These are the preventive measures that are put into place to minimize the possibility of suppliers providing unacceptable product. They include things such as supplier qualification, requirements placed on the supplier to be ISO 9000 certified, source inspection, receiving inspection, and so on.

Supply Chain Management This is the flow of items from raw materials to accepted products at the customer location. It is a methodology used to reduce cost, lead times, and inventory, while increasing customer satisfaction.

Surveys A systematic way to collect information about a specific subject by interviewing people. Often, the interview takes the form of a series of questions that are presented to a target audience either in written or verbal form.

Sustaining Sponsor Individual/group who has the political, logistical, and economic proximity to the individuals.

SWOT Analysis This stands for Strengths, Weaknesses, Opportunities, and Threat analysis. It is used to help match the organization's resources and capabilities to the competitive environment that exists in their market segment. It is often used as part of the strategic planning process.

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Synchronous Flow Manufacturing (SFM) SFM is a pull manufacturing system like Kanban, but it offers some apparent advantages over Kanban. In a Kanban system, each downstream operation pulls work from the next one upstream. In SFM, the only information transfer is between the capacity-constraining resource (CCR) and production starts. The CCR pulls work into the factory in the form of production starts. It is always desirable to keep a buffer of work in the line upstream of the CCR because a shortage at the CCR means an irrecoverable loss of production time.

System The organizational structure, responsibilities, procedures, and resources needed to conduct a major function within an organization or to support a common business need.

System Kaizen Improvement aimed at an entire value stream.

Systematic Design This is a very structured step-by-step approach to designing that was developed in Germany. It defines four main phases of the design process. They are

1. Clarification of the tests: collect information, formulate concepts, identify needs
2. Conceptual design: identify essential problems and subfactors
3. Embodiment: develop concepts, layouts and refinements
4. Detailed design: finalize drawings, concepts, and generate documentation

Tactic How the strategies will be implemented.

Takt Time Takt time is best described as the customer demand rate. It should be equivalent to the rate at which customers, internal or external, require the output. It drives the pull system as it eliminates the need for in-process stock. The process should be designed so that each step in the process is operating at the same takt time as the sales process. This is the ideal situation that keeps the process in continuous flow without buildup within the process or between processes.

A team is a small group of people who work together that realize their interdependencies and understand that both personal and team goals are best accomplished with mutual support.

Team Charter It is preferable that the team charter is defined by the Six Sigma leadership team. It is the major contribution they can make by providing clear direction and expectations. The team charter does not map the route for the project but does provide the boundaries and destination. It includes project objectives, project process boundaries, limitations, key deliverables, outside resources, and indicators/targets.

Team Management It is the coordination and facilitation of the activities that go on within the team to ensure that the effectiveness and efficiency of the team are optimized and the desired results are accomplished on schedule within cost.

Theory of Constraints (TOC) There is one point in every process that limits the flow through the process. The Theory of Constraints is used to identify these bottlenecks and eliminate them. This is a set of tools that examines the entire system to define continuous improvement opportunities. It consists of a number of tools. For example

- Transition Tree
- Prerequisite Tree
- Current Reality Tree
- Conflict Resolution Diagram
- Future Reality Tree

Throughput Time The time required for a product to proceed from concept to launch, order to delivery, or raw materials into the hands of the customer. This includes both processing and queue time.

Throughput Yield (TPY) This is the yield that comes out of the end of a process after any errors that are detected have been scrapped or reworked and reentered into the process. Effective rework procedures can often increase first-time yield from 10% to a throughput yield of 100%.

Total Cost Management A comprehensive management philosophy for proactively managing an organization's total resources (material, capital, and human resources) and the activities that consume those resources.

Total Productive Maintenance (TPM) This is a methodology used to keep the equipment within the organization at peak operating efficiency, thereby eliminating equipment downtime.

Total Productivity Management A methodology designed to direct the organization's efforts at improving productivity without decreasing quality. It is designed to eliminate waste by involving employees, effective use of information technology, and automation.

Total Quality Management (TQM) A methodology designed to focus an organization's efforts on improving quality of internal and external products and services. ISO 8402 defines it as: A management approach of an organization, centered on quality, based on the participation of all its members and aiming at long-term success through customer satisfaction and benefits to the members of the organization and to society. TQM is a conceptual, philosophical, and structured group of methodologies that require management and human resource commitment to the embodiment of a philosophy where all of the management, employees, processes, practices, and systems throughout the organization understand their customers, both internal and external, and provide them with organizational performance that fulfills or exceeds the customers' expectations. It is part of the evolution from quality control to statistical quality control to total quality control and it embodies all the criteria now included in all of the international, national, and local quality award systems.

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Toyota Production System The Toyota production system is a technology of comprehensive production management. The basic idea of this system is to maintain a continuous flow of products in factories to flexibly adapt to demand changes. The realization of such production flow is called just-in-time production, which means producing only necessary units in a necessary quantity at a necessary time. As a result, the excess inventories and the excess work force will be naturally diminished, thereby achieving the purposes of increased productivity and cost reduction.

Tree Diagrams Systematic approaches that help the user think about each phase or aspect of solving a problem, reaching a target, or achieving a goal.

Trial An observation made with all of the variables set at predesigned levels and held constant during the duration of the observation.

Tribal Knowledge This is any unwritten information that is not commonly known by others throughout the organization. It is part of a total organization's knowledge assets and one that is frequently lost as individuals change jobs or leaves the organization. Unlike other forms of intellectual assets, tribal knowledge cannot be converted into company property unless it is transformed into a hard knowledge base.

TRIZ This is a methodology that was developed in Russia and stands for "theory of innovative problem-solving." It was originated by Henrich Alashuller in 1946. It is effective at identifying low-cost improvement solutions during the define or identify phase. It is helpful in defining root cause of defects. This approach expands on systems engineering methodologies and provides a powerful system management method for problem definition and failure analysis. It is an effective approach to generating innovative ideas and solutions to problems. TRIZ is a Russian acronym.

Types of Data There are basically two major groupings of data. They are

- Attributes Data: The kind of data that is counted, not measured. It is collected when all you need to know is yes or no, go or no-go, accept or reject
- Variables Data: Variables data is used to provide a much more accurate measurement than attributes data provides. It involves collecting numeric values that quantify a measurement and therefore requires a smaller sample to make a decision

Types of Teams There are many different types of teams that are identified by different properties related to the team organization and objectives. Typical teams are

- Department Improvement Teams, focusing on individual area improvement opportunities
- Quality Circles, voluntary teams that form themselves
- Process Improvement Teams, typically working across functions, focusing on optimizing a total process typified by process reengineering and process redesign
- Task Forces, typified by an emergency that occurs within an organization
- Natural Work Teams, made up of individuals who are brought together to perform ongoing activities

Value A capability provided to a customer at the right time at an appropriate price, as defined in each case by the customer.

Value Chain Activities outside of your organization that add value to your final product, such as the value adding activities of your suppliers.

Value Stream This is all of the steps/activities (value-added, business-value-added, and non-value-added) in a process that the customer is willing to pay for.

Value-Added Analysis (VA) A procedure for analyzing every activity within a process, classifying its cost as value-added, business value-added, and no-value-added; and then taking positive action to eliminate the no-value-added cost and minimize the business value-added.

Value-Added to Non-Value-Added Lead Time Ratio Provides insight on how many value-added activities are performed compared to non-value-added activities, using time as a unit of measure.

Value Stream Costing Value Stream Costing methodology simplifies the accounting process to give everyone real information in a basic understandable format. By isolating all fixed costs along with direct labor we can easily apply manufacturing resources as a value per square footage used by a particular cell or value stream. This methodology of factoring gives a true picture of cellular consumption to value-added throughput for each value stream company wide. Now you can easily focus improvement kaizen events where actual problems exist for faster calculated benefits and sustainability.

Value-Stream Mapping This tool is used to identify waste in a process and help you understand the flow of materials and information as an item makes its way through the value stream. A value-stream map is a visual representation of a process and takes into account not only the item but also the management and information systems that support the basic item. This is helpful in working with cycle-time reduction problems and is primarily used as part of the lean tool kit.

(*Continued*)

Variables Data The kind of data that are always measured in units, such as inches, feet, volts, amps, ohms, and centimeters. Measured data give you detailed knowledge of the system and allow for small, frequent samples to be taken. These are data that are equivalent to quantitative data. There are two types of variable data: discrete (count-type data) and continuous data.

Variation This is a measure of the changes in the output from the process over a time. It is typically measured as the average spread of the data around the mean and is sometimes called noise.

Vision A description of the desired future state of an organization, process, team, or activity.

Visual Management (Controls) The placement in plain view of all tools, parts, production activities, and indicators of production system performance so everyone involved can understand the status of the system at a glance. Known as a set of techniques that makes operation standards visible so that workers can follow them more easily. These techniques expose waste so that it can be prevented and eliminated.

Vision Statement A group of words that paints a clear picture of the desired business environment 5 years in the future. A visions statement should be between two and four sentences.

Visual Factory/ Visual Office This is a system of signs, information displays, layouts, material storage, and equipment storage. It uses color coding and error-proofing devices. The five Ss are part of visual controls and the visual office. Typical tools used in the visual office or control center would be a continuously updated electronic sign indicating the number of clients that are waiting for their phone call to be answered, or the length of time it takes to respond to a phone inquiry.

Vital Few This is the 20% of the independent variables that contribute to 80% of the total variation.

Voice of the Business (VOB) This describes the stated and unstated needs and requirements of the organization and its stakeholders.

Voice of the Customer The customer's expression of their requirements, in their own terms. It describes the stated and unstated needs and requirements of the external customer.

Voice of the Employee (VOE) This is the term used to describe the stated and unstated needs and requirements of the employees within your organization.

Voice of the Process (VOP) This is the term used to describe what the process is telling you about what it is capable of achieving.

Waste (a.k.a. Muda) Anything that uses resources, but does not add real value to the product or service. Any activity that uses equipment, materials, parts, space, employee time, or other corporate resource beyond the minimum amount required for value-added operations to insure manufacturability.

Waste Identification	The ability to "see" waste in your organization. This encompasses readily identifying the eight waste categories in all your processes.
Waste Elimination	The ability to apply Lean Concepts and Tools to eliminate identified wastes.
Work Breakdown Structure (WBS)	This is a Gantt chart used in project management to monitor and plan the activities related to doing the project as well as defining their interrelationships and their present status.
Work Flow Monitoring	An online computer program that is used to track individual transactions as they move through the process to minimize process variation.
Work-in-Process (WIP)	Product or inventory in various stages of completion throughout the plant, from raw material to completed product.
Work Standards	When work standards are practiced, everyone in the organization is committed to performing the work in the same best way. Work standards include documentation methods and developing engineering standards to set expectation and measurement matrix. They provide job aids and training to the employees that effectively communicate the best ways to perform an activity and sets the minimum performance standard for the trained employee.
World-Class Operations Benchmarking	A form of external benchmarking that extends the benchmarking approach outside the organization's direct competition to involve dissimilar industries.
Xs	In Six Sigma, *Xs* are all the inputs that are required to produce the output Y. It includes the 6 m's; materials, machinery, manpower, methods, measurements, and mother nature. Virtually all process improvement projects involve changes to the X input variables in order to improve output results.
Zero Defects	This was a complete system directed at eliminating all defects from a product. It was originated by Phil Crosby on a military contract and spread throughout the world. It sets a higher standard for performance than Six Sigma by 3.4 defects per million opportunities. It focused on perfection, which is impossible to reach but should be our objective.

Business Management

THE LEAN MANAGEMENT SYSTEMS HANDBOOK

Performance management, the primary focus of a Lean organization, occurs through continuous improvement programs that focus on education, belief systems development, and effective change management. Presenting a first-of-its-kind approach, **The Lean Management Systems Handbook** details the critical components required for sustainable Lean management.

Positioning Lean as a management operational philosophy far beyond the traditional set of improvement tools, the book explains how managers at all levels of an organization can integrate Lean into their daily management activities. It defines the Lean philosophy as well as the beliefs and behaviors required to develop a thriving Lean company culture.

The book captures the essence of Lean learning and Lean doing and illustrates practical applications of Lean management. It begins by covering the basics that encompass Lean management and leadership in two critical areas: maintenance/control and improvement.

After reading this book, you will better understand how to see waste, measure waste, eliminate waste, and develop an active change improvement workplace. You will also gain the practical understanding required to determine which Lean tool is best suited to your particular need for supporting an organization-wide management system.

Expounding on essential Lean concepts, this is an ideal guide to help new managers and leaders make the transition from theory to successful application in the field. Complete with brief summaries and examples of the most important tools in Lean management systems development in each chapter, the book provides a reliable roadmap for deploying a Lean management system across your organization and, subsequently, across your entire value stream.

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